

Emergency Medicine Simulation Workbook

A TOOL FOR BRINGING
THE CURRICULUM TO LIFE

Edited by Traci L. Thoureen and Sara B. Scott



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Companion website

This book is accompanied by a companion website:

www.wiley.com/go/thoureen/simulation/workbook

The website includes:

- Imaging and laboratory results pertinent to each case study.
- Powerpoint format suitable for printing out, downloading, or real-time use on-screen during the simulation session.
- Additional video clips to simulate sonogram results are presented for the ruptured ectopic pregnancy case study (Chapter 8).

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CURRICULUM TO LIFE

Edited by

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Foreword

The growth of technology-enhanced simulation training in health care over the last decade represents a transformative era in the history of medical education. No longer do “time and chance” clinical encounters alone dictate the experiential training profile of the learner; rather, realistic clinical scenarios can be animated through a combination of advanced technology and role-play, creating a safe and standardized environment in which to practice care of even the sickest patients.

This latter concept – caring for the sickest patients in the safest environment – captures a unique intersection between Emergency Medicine and modern simulation-based learning. Only with the benefit of advanced simulation tools can the sickest patients be realistically portrayed for real-time teaching and learning. This creates a unique opportunity for educators in the field of Emergency Medicine to make important contributions to modern medical education, across disciplines. This book, essentially providing a ready-to-deploy experiential curriculum that touches all specialties, represents just such an advance.

The synergy between Emergency Medicine and simulation education is not only practical, but also highlights important aspects of human cognition and learning theory that we are only just beginning to understand. Encountering a critically ill robot simulator, as paradoxical as that may sound, can reliably stimulate a unique level of emotional engagement among learners. This kind of intense engagement, in and of itself, provides a foundation for critical thought, action, and memory that many associate only with key moments of actual clinical experience – but without any of the inherent risk to real patients. Not surprisingly, medical simulation is becoming a core element of the global patient safety effort, and simulation practice across all fields is increasingly viewed as a quality and safety imperative.

While this book represents an invaluable resource to any Emergency Medicine educator, it also provides a roadmap to help all medical educators explore the unique benefits of medical simulation. The cases chosen for inclusion are drawn from a diverse group of faculty authors across a wide range of medical teaching centers, and represent a full spectrum of pathology. The material is formatted and annotated so that cases can be tailored to novice or advanced learners, and easily deployed in a diversity of settings. Key “tips or tricks” are included to accompany case images and other patient data which complete the compendium, allowing for standardized use as part of a tailored teaching and assessment portfolio.

I have been fortunate to witness the evolution of modern simulation in health care from a handful of pioneering initiatives to a unified specialty field that is flourishing across the globe. This book represents a movement to consolidate and distribute

lessons learned during this period of extraordinary growth, providing a key tool to make simulation more accessible to all medical educators.

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CHAPTER 1 **Introduction: How to use this book**

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Simulation has become an integral tool in medical education and the specialty of emergency medicine (EM) is no exception. Simulation curriculums have increasingly become integrated into standard EM training. In fact, as of 2008, one study reported that of 134 EM residencies surveyed in the United States, 91% used some form of simulation in their postgraduate training.¹

With increasing utilization of simulation as a teaching tool, there has been more demand from educators for workshops and training that focus on how to teach using simulation. This workbook is designed with those demands in mind. It is meant to act as a “lesson plan” for physician educators to use at the “bedside” in the simulation laboratory or in any space that is used to conduct simulation.

This workbook is organized with the basic clinical competencies of EM in mind. The chapters incorporate topics listed by the American Board of Emergency Medicine as included in the certification examination. Each chapter includes 3–4 individual simulation cases that highlight subject material pertinent to the chapter topic. In many of the cases, alternative options are described for use with multiple levels of learners (students, junior or senior postgraduate learners).

Although each individual simulation case is unique, the presentation format for all of the cases is the same. The layout for each case starts with specific educational objectives for that case, together with a list of suggested critical actions. For those who are working within the United States postgraduate training system, we have notated the relevant Accreditation Council of Graduate Medical Education (ACGME) clinical competencies for each learning objective and critical action.

Immediately following the critical actions, you will find an outline for the case set-up. This includes a description of the physical environment, mannequin, props, distractors, and actors that are recommended for each simulation. To aid in the case set-up, an online resource is provided with this workbook (at www.wiley.com/go/thoureen/simulation/workbook) and includes imaging and laboratory studies pertinent to each case. The online resource is presented in a PowerPoint format and can be printed out, downloaded, or shown in real time on computer screens/monitors during the simulation session.

After the section on set-up, you will find a brief narrative of the case, which essentially contains the information found on most emergency department triage sheets. There is a description of the initial mannequin conditions and a case narrative which details the changes in conditions that will occur in the mannequin after a specific time

interval or in response to a learner intervention. Accompanying flow sheets also outline the general sequence of actions for each case.

Throughout the case, you will see text boxes. These text boxes highlight specific details in the case that can be altered based on the degree of fidelity of your mannequin or on the skill level of your learner. In this way, each case can be manipulated to fit your teaching needs and available resources.

At the end of each case, you will find information to aid in debriefing. Instructor notes provide basic background information for your facilitators about the specific case topic. There is also a list of potential questions that can be used during the debriefing session with your learners. Finally, you will find a list of selected reading that can be used in preparing for the simulation and some are suitable to be distributed to learners either prior to or following the simulation.

We hope that you will find this workbook a useful tool in the development or continuation of a successful emergency medicine simulation curriculum at your institution. Keep in mind that each simulation case is dynamic and can be modified in a variety of ways to suit best the needs of your learners and/or the fidelity of your mannequin. As such, this workbook provides a basic template for the design of an emergency medicine simulation curriculum for learners at any stage in their education and for facilities with varying levels of technical capability.

Reference

1. Okuda Y, Bond W, Bonfante G, *et al.* National growth in simulation training within emergency medicine residency programs, 2003–2008. *Acad Emerg Med* 2008;**15**(11):1113–1116.

CHAPTER 2 **Vascular emergencies**

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Pulmonary embolism

Educational goals

Learning objectives

Primary:

1. Recognize clinical signs of pulmonary embolism (PE) [*Medical Knowledge*].
2. Order appropriate diagnostic tests for PE [*Medical Knowledge*].
3. Order appropriate treatment for PE and its complications [*Medical Knowledge, Patient Care*].

Secondary:

1. Demonstrate professionalism and communication skills in consultation with other physicians and in working with ED nurse [*Interpersonal and Communication Skills, Professionalism*].
2. Direct proper disposition to/appropriate consultation with the ICU [*Systems-based Practice*].

Critical actions checklist

- ☐ Assess airway, breathing, and circulation [*Patient Care*]
- ☐ Place patient on cardiac monitor and establish IV access [*Patient Care*]
- ☐ Order CT angiography (or locally appropriate imaging) and recognize signs of PE [*Medical Knowledge*]
- ☐ Initiate proper therapy: (1) heparin and/or thrombolytic for PE, (2) high-flow oxygen/non-invasive positive-pressure ventilation/intubation for hypoxia, and (3) IV vasopressor for hypotension/shock [*Medical Knowledge, Patient Care*]
- ☐ Call and communicate to ICU for disposition [*Interpersonal and Communication Skills, Professionalism*]

Critical actions can be changed to address the educational needs of the learner. For example, a resident preparing for the oral board examination may have more specific critical actions such as ordering a pregnancy test before radiologic imaging, etc.

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin, on a stretcher or hospital bed. Mannequin should be female, mouldaged with left leg swelling.

This moulage may be accomplished in both high and low-tech ways. You may purchase SimLeggings™ (Eriter Creations, Stirling, AB, Canada) or, for a lower tech version, nude-colored self-adherent elastic wrap can be placed overtop of memory foam ($\frac{1}{4}$ – $\frac{1}{2}$ inch) with nude pantyhose on top, or simply a label or photograph of your desired appearance can be placed on the extremity.

Props: To be displayed on plasma screen/computer screen or printed out on handouts in scenario room when asked for/return from laboratory.

- Images (see online component for Pulmonary Embolism, *Scenario 2.1.ppt*, at www.wiley.com/go/thoureen/simulation/workbook)
 - ECG with sinus tachycardia.
 - Chest X-ray showing normal cardiac silhouette.
 - CT angiography of chest showing right-sided PE.
 - Venous Doppler ultrasound of left leg showing deep venous thrombosis.
- Labs (see online component as above)
 - Complete blood count.
 - Chemistry panel.
 - Coagulation panel.
 - Urinalysis.
 - Urine pregnancy test.
 - D-dimer.

Available in the treatment room:

- Basic airway and code cart.
- High-flow face mask.
- Medications:
 - Liter bags of 0.9% normal saline (NS) and lactated Ringer's (LR).
 - Rapid sequence intubation (RSI) medications pre-labeled in syringes (paralytic and induction medication of choice for your institution).
 - Heparin in pre-labeled liter bag.
 - Thrombolytic typically utilized at your institution.
- Non-invasive positive pressure airway equipment (BiPAP or CPAP).

Distractor: None.

Actors:

- Husband (optional). Available to provide additional information either in person or via telephone.
- Patient voice is female. Patient should sound short of breath, speaking in truncated sentences at the beginning of the scenario.
- ED nurse can start IVs and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed.
- ICU physician can be available via "phone consultation."

Case narrative

Scenario background

A 27-year-old female with shortness of breath and pleuritic chest pain that started this morning. She used her albuterol inhaler a few times this morning without any improvement in her symptoms. She reports a mild cough and chest discomfort with the cough. No fever or orthopnea.

Background may be presented prior to case, by husband, or given as a triage sheet.

CC: Shortness of breath.

PMH: Asthma.

Meds: Albuterol inhaler, oral contraceptive pill.

Allergies: None.

Family Hx: Unremarkable.

Social Hx: Smokes one pack per day, occasional alcohol, no illicit drugs. She was recently married and returned one week ago from honeymooning in Europe (she lives in the United States).

Travel history can be volunteered or given only if asked to adjust to level of learners.

Initial scenario conditions

Patient is tachypneic, anxious:

"I just . . . can't . . . breath . . . it hurts . . . it feels . . . tight . . ."

VS: Temp. 37.5 °C (99.5 °F), HR 118, RR 24, BP 110/60, O₂ sat 91% RA.

Heart: Tachycardia, no murmurs.

Lungs: Tachypneic, equal bilaterally, clear to auscultation.

Extremities: Left lower leg swollen, calf is slightly tender if palpated by the examiner.

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners, e.g. left leg swelling can be reported by patient if asked by the participants if none of the suggested moulage techniques listed above are available for your scenario.

See the flow diagram in Figure 2.1 for further scenario changes described below.

Case narrative, continued

The respiratory distress will continue and gradually worsen as the scenario progresses, despite bronchodilator treatment and supplemental oxygen. Diagnostic tests (mainly imaging) should be ordered prior to decompensation of the patient, but may also be obtained after intubation and stabilization if the learner does not pick up on prompts.

Whether or not the correct diagnosis of PE is made, the patient will continue to deteriorate and develop hypoxia and hemodynamic instability in the form of significant hypotension. At this point, the patient should be intubated and mechanically ventilated. If not intubated, the patient will go into pulseless electrical activity (PEA) rhythm and require resuscitation. You may make the option for students and junior learners to have the case end after intubation and heparin administration.

For senior learners, you can move on to Phase II and the patient will have worsening hypoxia and hypotension necessitating vasopressors and thrombolytics for stabilization.

Ultimately, the learner will need to admit the patient to an ICU level of care. However, if the learners try to admit the patient to the ICU prior to thrombolytics, the intensivist may be “unavailable” or state that the ICU is full and the patient must be managed in the ED until they have a bed.

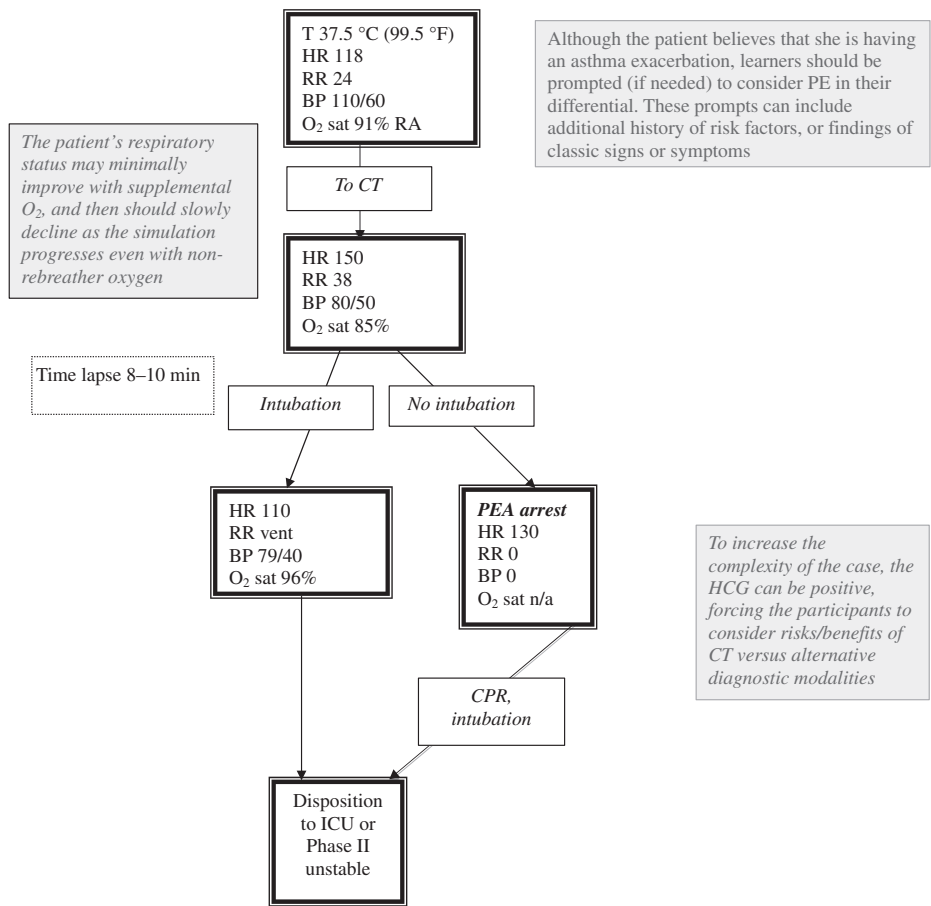


Figure 2.1 Scenario flow diagram: pulmonary embolism.

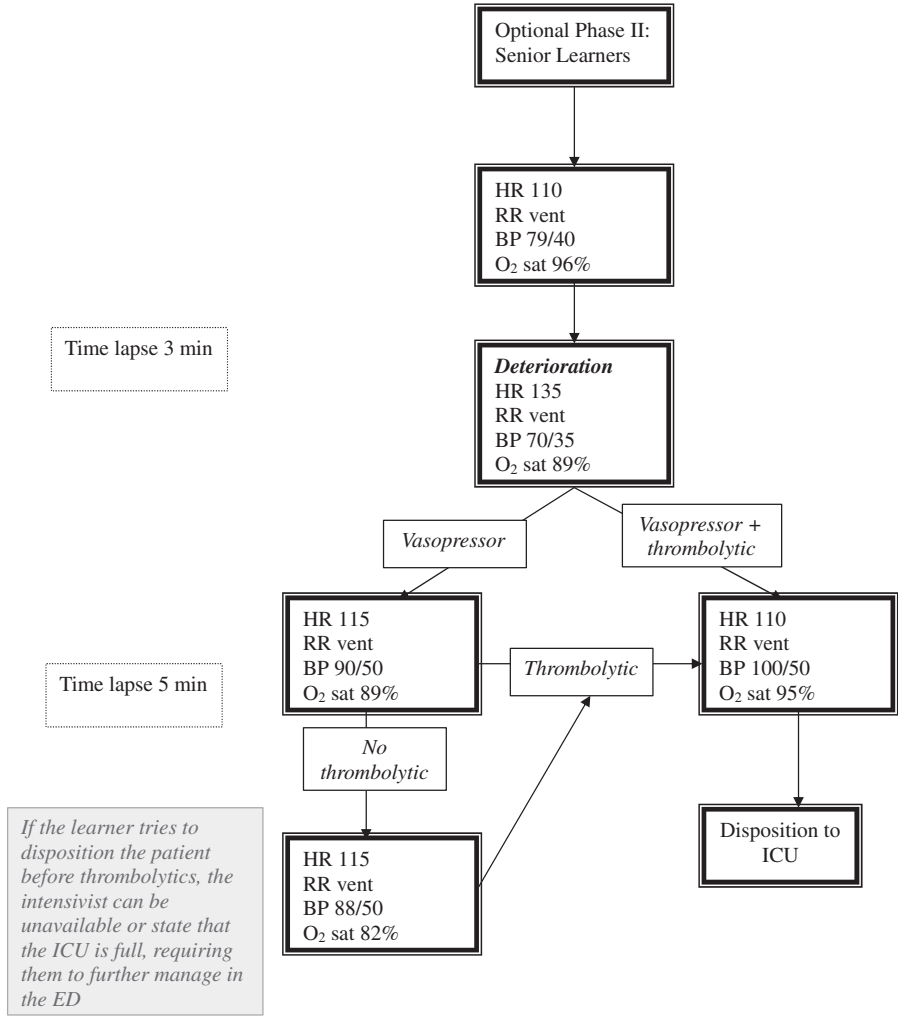


Figure 2.1 (Continued)

Instructor notes

Pathophysiology

PE describes the process where a pulmonary artery is occluded by thrombus, fat, air, or amniotic fluid:

- Impaired gas exchange due to ventilation/perfusion (VQ) mismatch.
- Increased pulmonary vascular resistance.
- Increased wall tension in the right ventricle → bulging of the interventricular septum → compression of the left ventricle → decreased in cardiac output.

Clinical features

- Dyspnea is the most common chief complaint.
- Other symptoms:
 - Pleuritic pain.
 - Cough.
 - Hemoptysis.
 - Syncope.
- Clinical signs can include:
 - Tachypnea.
 - Tachycardia.
 - Hypoxia.
 - Low-grade fever.
 - Neck vein distention.
 - Examination findings consistent with DVT, i.e. extremity swelling.

Diagnosis

- Clinical decision rules
 - Risk-stratifying tools that do not definitively rule out PE.^{2,3}
 - PERC (pulmonary embolism rule-out criteria): If all eight are positive there is <2% chance of PE:
 - Age <50 years.
 - Pulse <100 beats/min (-1).
 - O₂ sat ≥95%.
 - No hemoptysis.
 - No estrogen use.
 - No surgery/trauma requiring hospitalization within 4 weeks.
 - No prior venous thromboembolism (VTE).
 - No unilateral leg swelling.
 - Wells criteria: Assigns risk of PE based on points; >7.5 points is high-risk group, ≤4 points is low-risk group.
 - Clinical signs and symptoms of DVT (+3).
 - PE as most likely diagnosis (+3).
 - Tachycardia (+1.5).
 - Immobilization for at least 3 days or recent surgery within 4 weeks (+1.5).

- History of PE or DVT (+1.5).
 - Hemoptysis (+1).
 - History of malignancy (+1).
- Imaging
 - CT angiogram:
 - Preferred modality.
 - PE is indicated by a filling defect within the pulmonary artery.
 - Ventilation-perfusion scan:
 - High probability for a PE indicated by a segmental area of decreased perfusion that has normal ventilation.
 - Venous ultrasound of the lower extremities:
 - The loss of vein compressibility in the legs indicates a DVT.
 - A negative study cannot definitively rule out PE.
- Less specific diagnostic tests include:
 - D-dimer serum assay:
 - May use in groups assessed as low risk to rule out PE.
 - Electrocardiogram:
 - Sinus tachycardia.
 - S1Q3T3 (inverted S in lead I, Q wave and inverted T wave in lead III).
 - Right ventricular strain pattern.
 - Chest X-ray:
 - Usually normal, but may show focal oligemia (Westermarck's sign), peripheral wedge-shaped density (Hampton's hump), or enlarged right descending pulmonary artery (Palla's sign).

Management

- Supplemental oxygenation \pm ventilatory support.
- Anticoagulation:
 - Unfractionated heparin is usually the initial drug of choice:
 - Initial bolus 80 units/kg followed by initial infusion rate 18 units/kg/h. Titrate to therapeutic activated partial thromboplastin time of twice the control value.
- Inotropic support:
 - Dobutamine:
 - Positive inotrope and a pulmonary vasodilator, making it a prime choice during right heart failure caused by PE.
 - Initial rate: 2 μ g/kg/min.
- High-morbidity patients:
 - Surgical embolectomy.
 - Thrombolysis:
 - Tissue plasminogen activator (tPA): 100 mg IV over 2 h.

Debriefing plan

Plan for ~30 min for discussion.

Potential questions for discussion

- What other diagnoses should be considered in a patient who presents like the woman in this case?
- What risk factors for PE should be ascertained in the history?
- What decision rules (PERC, Wells) are available to aid in risk stratification, and how should they be used?
- How and when should a D-dimer test be used?
- What are the characteristic ECG findings of pulmonary embolism?
- How do the diagnostic work-up and treatment choices change if the patient is pregnant?
- What is the vasopressor of choice in right heart failure due to PE?

Selected reading

1. Laack TA, Goyal DG. Pulmonary embolism: an unsuspected killer. *Emerg Med Clin N Am* 2004; **22**:961–983.
2. Kline JA, Courtney DM, Kabrhel C, *et al.* Prospective multicenter evaluation of the pulmonary embolism rule-out criteria. *J Thromb Haemost* 2008; **6**(5):772–780.
3. Wells PS, Anderson DR, Rodger M, *et al.* Excluding pulmonary embolism at the bedside without diagnostic imaging: management of patients with suspected pulmonary embolism presenting to the emergency department by using a simple clinical model and D-dimer. *Ann Intern Med* 2001; **135**(2):98–107.
4. Wolf SJ, McCubbin TR, Feldhaus KM, *et al.* Prospective validation of Wells criteria in the evaluation of patients with suspected pulmonary embolism. *Ann Emerg Med* 2004; **44**(5):503–510.
5. Agnelli G, Becattini C. Review article: acute pulmonary embolism. *N Engl J Med* 2010; **363**:266–274.

Aortic dissection

Educational goals

Learning objectives

Primary:

1. Recognize clinical signs of aortic dissection (AD) [*Medical Knowledge*].
2. Order appropriate diagnostic tests for AD [*Medical Knowledge*].
3. Order appropriate therapy for management of acute AD and its complications [*Medical Knowledge, Patient Care*].

Secondary:

1. Demonstrate professionalism and communication skills in consulting the surgeon and working with ED nurse [*Interpersonal and Communication Skills, Professionalism*].
2. Direct proper disposition/appropriate consultation [*Systems-based Practice*].

Critical actions checklist

- ☐ Assess airway, breathing, and circulation [*Patient Care*]
- ☐ Place patient on a cardiac monitor and establish IV access [*Patient Care*]
- ☐ Order ultrasound or CT and recognize signs of dissection [*Medical Knowledge*]
- ☐ Initiate proper therapy: IV beta-blocker \pm sodium nitroprusside or calcium channel blockers [*Medical Knowledge, Patient Care*]
- ☐ (Optional) Perform pericardiocentesis \pm intubation [*Medical Knowledge*]
- ☐ Call and communicate to cardiothoracic surgeon for disposition [*Interpersonal and Communication Skills, Professionalism*]

Critical actions can be changed to address the educational needs of the learner.

Simulation set-up

Environment: Emergency department treatment area.

Mannequin: Male simulator mannequin, no moulage, on a stretcher or hospital bed.
Option: additional torso trainer for performing pericardiocentesis in the simulation area hidden under a sheet until the procedure is needed.

Props: To be displayed on plasma screen/computer screen or printed out on handouts in scenario room when asked for/return from laboratory:

- Images (see online component for Aortic Dissection, *Scenario 2.2.ppt*, at www.wiley.com/go/thoureen/simulation/workbook)
 - ECG showing a sinus rhythm with no abnormalities.
 - Chest X-ray showing a widened mediastinum.
 - CT angiography of chest, abdomen, and pelvis (one slice shown from the chest portion) showing a filling defect indicating false lumen of aortic dissection, originating from the ascending aorta through the left proximal iliac artery.
 - Ultrasound image of pericardial effusion.
- Labs (see online component as above)
 - Complete blood count.
 - Chemistry panel.

Other labs that the learners order can be “pending.”

Available in the treatment room:

- Basic airway and code cart.
- Medications:
 - Liter bags of 0.9% normal saline (NS) and lactated Ringer’s (LR).
 - Rapid sequence intubation (RSI) medications pre-labeled in syringes (paralytic and induction medication of choice for your institution).
 - IV beta-blockers in pre-labeled syringes/IV bags (e.g. labetalol, esmolol, propranolol).
 - IV calcium channel blockers.
 - Nitroprusside.
 - IV analgesics in pre-labeled syringes (e.g. morphine, fentanyl).
- Pericardiocentesis kit or spinal needle and 30 cc syringe.

Distractor: The patient may be distracting to the learners as he continually tries to ask for pain medication for his leg, “I have a high tolerance, my leg really hurts!”

Actors:

- Patient voice is male and may be demanding (see distractor above)
- ED nurse can start IVs and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed.

- Cardiothoracic surgeon available via “phone consultation.”

Making the consulting surgeon temporarily unavailable (scrubbed in a case, performing a procedure, or just not returning pages) will enhance the difficulty of the scenario for advanced learners.

Scenario background

A 55-year-old male presents to the Emergency Department from home complaining of severe, gnawing chest pain onset shortly after a breakfast of two egg sandwiches from the fast food restaurant. "It must have been those sandwiches; I just don't feel good." He denies any shortness of breath in the initial portion of the scenario, if asked.

Background may be presented prior to case or given as a triage sheet.

CC: Chest pain.

PMH: Hypertension.

Meds: Methadone, amlodipine, lisinopril, hydrochlorothiazide.

Allergies: Haloperidol.

Family Hx: Hypertension, diabetes.

Social Hx: Smokes one pack of cigarettes per day, occasional alcohol, on methadone for history of opioid abuse, occasionally smokes cocaine (last used yesterday).

Initial scenario conditions

Middle-aged male is uncomfortable sitting up on the stretcher. He asks for pain medicine frequently during the interview, stating "My (left) leg hurts."

VS: Temp. 36.6 °C (97.8 °F), HR 98, RR 14, BP 210/108, O₂ sat 97% RA.

Neck: No jugular venous distention (JVD).

Heart: Regular rate and rhythm, no murmurs.

Lungs: Equal bilaterally, clear to auscultation.

Extremities: Femoral and pedal pulse decreased on left (1+) as compared with right (2+). Strength and sensation are grossly intact.

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners, e.g. pulse discrepancy may not be easily simulated and may need to be verbally reported by the nurse when the learners feel for a pulse.

See the flow diagram in Figure 2.2 for further scenario changes described below.

Case narrative, continued

The patient, despite presenting to the emergency department chiefly for chest pain, continuously complains about pain in his leg, and will ask multiple times for more pain medications. The learner must manage these requests throughout the case.

The blood pressure and heart rate will remain elevated, requiring aggressive use of parenteral antihypertensive medications. If the learner does not order blood pressure medication, the patient will become nauseous and vomit, becoming even more hypertensive. If the learners do not increase dosing of antihypertensives or add a second antihypertensive medication, the patient will be crying in pain from his leg and the nurse notes that she now cannot feel a pulse in the leg. The nurse may prompt learners at this time to give medications to address the problem or can guide the learners to come up with the diagnosis and order imaging if they have not done this already. Students and junior learners can end the scenario with surgery consultation after the CT reading returns.

Senior learners or astute students and junior learners who have managed the case easily can then progress to Phase II: cardiac tamponade. The patient will become tachypneic and hypotensive, indicating proximal propagation of the dissection that is now causing cardiac tamponade. The nurse may prompt the learners that an ultrasound if available if they do not order it. An emergency pericardiocentesis will need to be performed or the procedure may be verbally explained if a torso trainer is not available. The learners may also intubate the patient for his critical status and to obtain a CT safely if not already done. If the learner does not recognize tamponade, the patient will go into PEA arrest and require CPR and pericardiocentesis for resuscitation.

Ultimately, the patient will be transferred to the care of a surgeon at the end of the scenario.

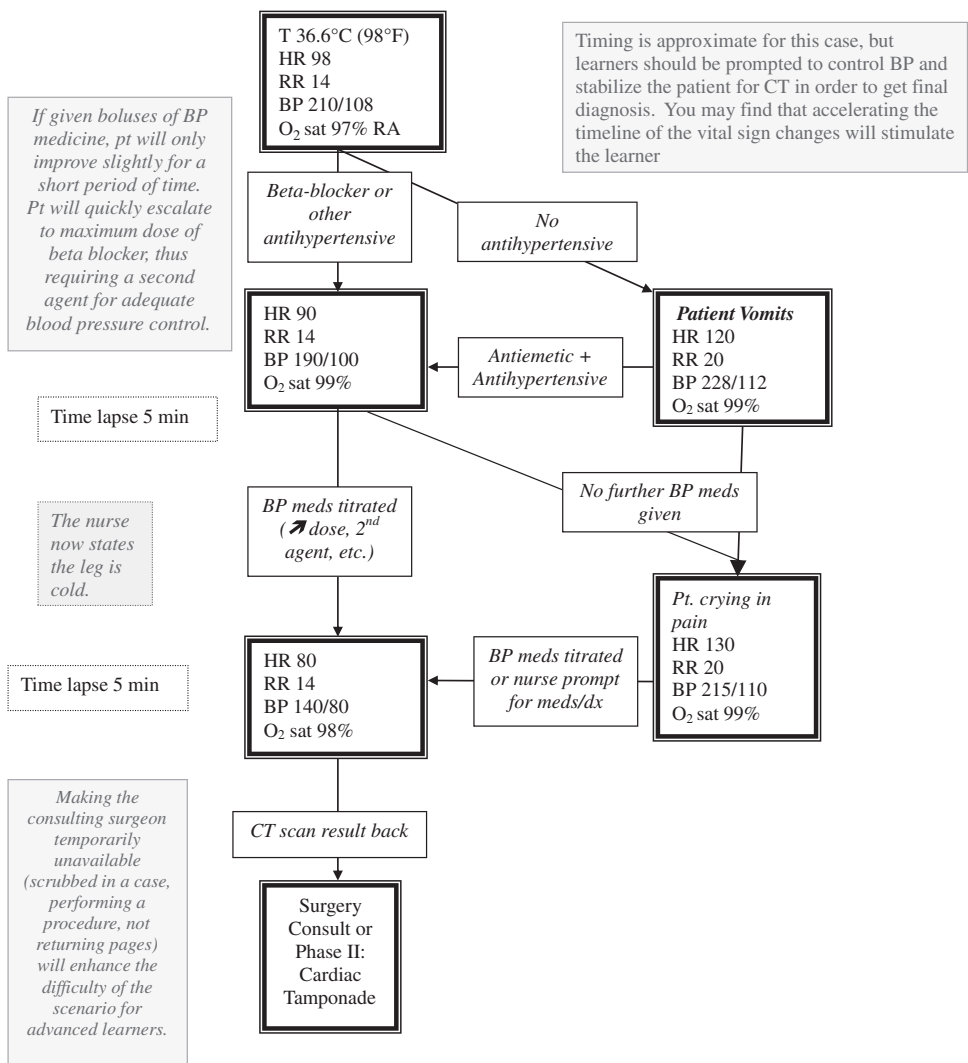


Figure 2.2 Scenario flow diagram: aortic dissection.

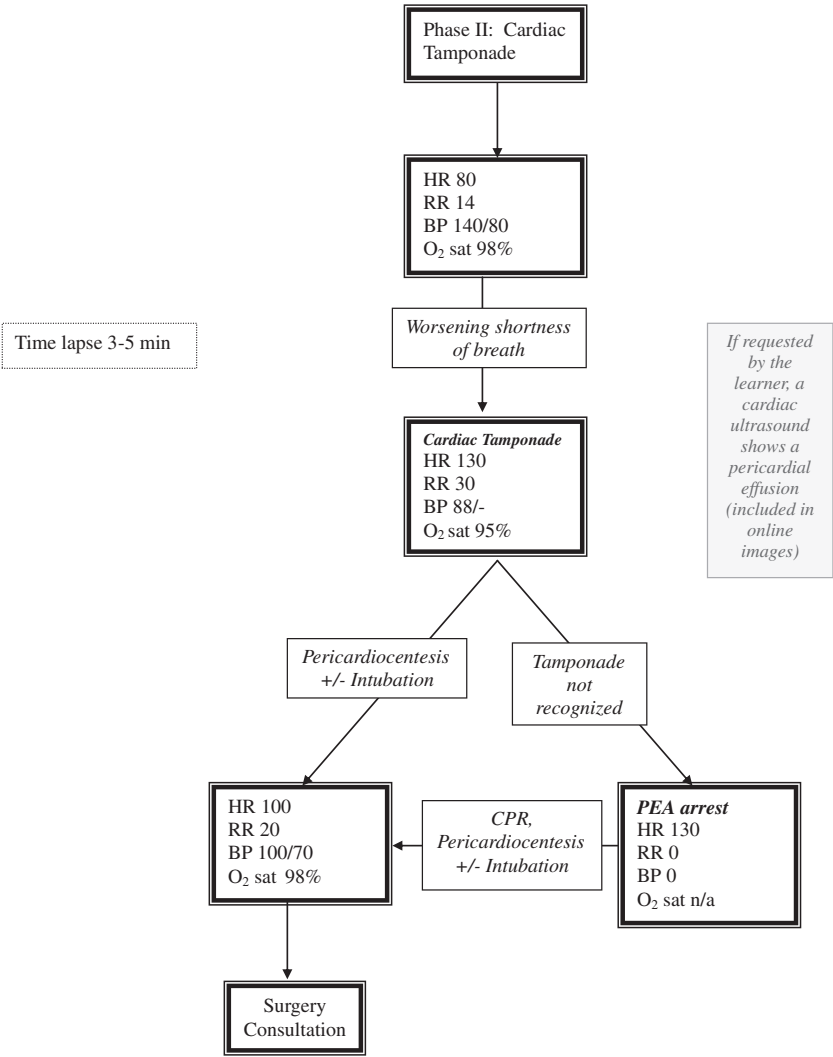


Figure 2.2 (Continued)

Instructor notes

Pathophysiology

- Caused by a tear in the intimal layer of the aorta, which allows blood to dissect along the plane creating a false lumen.
- Classifications
 - Stanford and DeBakey (anatomically based).
 - The Stanford classification is more closely aligned with clinical practice and management:
 - Type A (ascending aorta or proximal dissection) → surgical correction.
 - Type B (descending aorta or distal dissection) → medical therapy with surgical correction considered if there is propagation of the dissection, compromise of aortic branches, or impending rupture.

Clinical features

- Chest or back pain, often described as severe and tearing in nature.
- Syncope.
- Hypotension.
- Weakness:
 - Possible complications:
 - Propagation of dissection into major arteries causing stroke.
 - Myocardial infarction.
 - Renal failure.
 - Bowel or limb ischemia.
 - Cardiac tamponade if there is proximal propagation.

Risk factors

- Hypertension.
- Age; peak incidence 60–70 years old.
- Male gender.
- Pregnancy.
- Bicuspid aortic valve.
- Coarctation of aorta.
- Connective tissue disease: Marfan, Ehlers–Danlos, Turner syndromes.
- Cocaine.

Diagnosis

- Physical examination:
 - Pulse deficit:
 - Present in only 25–30% of acute aortic dissection (AD), but when present in a patient with chest or back pain is highly suggestive of AD.
- Imaging:
 - CT scan of chest/abdomen/pelvis with IV contrast:
 - Identifies dissection flap and extent of dissection, including propagation to end organs.

- MRI:
 - Consider if unable to give IV contrast.
 - Significant time delay to diagnosis.
- Laboratory tests:
 - D-dimer:
 - Initial studies have suggested that AD is unlikely in the setting of a negative D-dimer.

Management

- Medical therapy:
 - IV beta-blockers (e.g. labetalol, esmolol, propranolol):
 - Reduce cardiac contractility.
 - Additional antihypertensive agents (target mean arterial pressure of 60–75 mmHg):
 - Nitroprusside.
 - Calcium channel blockers.
 - Direct vasodilators such as hydralazine are contraindicated as they can increase hydraulic shear and cause propagation of the dissection.
- Surgical repair:
 - Preferred for ascending aorta dissections (Type A) or complicated descending aorta dissections (Type B).

Debriefing plan

Plan for ~30 min for discussion.

Potential questions for discussion

- What are some risk factors for aortic dissection?
- What other processes should be considered in the differential diagnosis for this patient?
- What findings on examination or imaging suggest a proximal dissection?
- Are there any antihypertensive medications that are contraindicated in acute dissection, and why are they contraindicated?

Selected reading

1. Rosman HS, Patel S, Borzak S, *et al.* Quality of history taking in patients with aortic dissection. *Chest* 1998;**114**:793–795.
2. Spittell PC, Spittell JA, Joyce JW, *et al.* Clinical features and differential diagnosis of aortic dissection: experience with 236 cases. *Mayo Clin Proc* 1993;**68**:642–651.
3. Haro L, Krajicck M, Lobl J. Challenges, controversies, and advances in aortic catastrophes. *Emerg Med Clin N Am* 2005;**23**:1159–1177.
4. Rogers R, McCormack R. Aortic disasters. *Emerg Med Clin N Am* 2004;**22**:887–908.

Abdominal aortic aneurysm

Educational goals

Learning objectives

Primary:

1. Recognize clinical signs of ruptured abdominal aortic aneurysm (AAA) [*Medical Knowledge*].
2. Order appropriate diagnostic tests for AAA [*Medical Knowledge*].
3. Demonstrate appropriate treatment for AAA [*Medical Knowledge, Patient Care*].

Secondary:

1. Demonstrate professionalism and communication skills in consulting the surgeon and working with ED nurse [*Interpersonal and Communication Skills, Professionalism*].
2. Direct proper disposition/appropriate consultation [*Systems-based Practice*].

Critical actions checklist

- ☐ Assess airway, breathing, circulation [*Patient Care*]
- ☐ Place patient on monitor and establish additional IV access [*Patient Care*]
- ☐ Perform/order ultrasound (US) or order CT to diagnose AAA [*Medical Knowledge, Patient Care*]
- ☐ Order type and cross-matched packed red blood cells when diagnosis of rupture is suspected [*Medical Knowledge, Patient Care*]
- ☐ Call and communicate to vascular surgery for disposition [*Interpersonal and Communication Skills, Professionalism*]

Critical actions can be changed to address the educational needs of the learner. For example, a student learner may not be expected to interpret results of a bedside ultrasound, whereas a senior learner would be expected to do so.

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin with single 20-gauge peripheral IV in place, toes on both feet should be moulaged to appear cyanotic, on a stretcher or hospital bed with a sheet covering the lower extremities.

Props: To be displayed on plasma screen/computer screen or printed out on handouts in scenario room when asked for/return from laboratory:

- Images (see online component for Abdominal Aortic Aneurysm, *Scenario 2.3.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG showing normal sinus rhythm.
 - Chest X-ray showing normal cardiac silhouette.
 - Ultrasound image of aorta that shows a 3.4×4 cm AAA.
 - CT angiography of chest/abdomen/pelvis that shows a 4×4 cm fusiform AAA.
 - Radiology report of CT head that is normal.
- Labs (see online component as above):
 - Complete blood count.
 - Chemistry panel.
 - Liver function tests.
 - Coagulation panel.
 - Urinalysis.
 - Urine microscopy
 - Urine toxicology screen.
 - Cardiac enzymes.

Available in the treatment room:

- Basic airway and code cart.
- Medications:
 - Liter bags of 0.9% normal saline (NS) and lactated Ringer's (LR).
 - Rapid sequence intubation (RSI) medications pre-labeled in syringes (paralytic and induction medication of choice for your institution).
- Labeled bags of packed red blood cells.

Distractor: None.

Actors:

- Patient voice is male.
- Patient's co-worker. He or she was the witness to the syncopal episode. This person may be available by telephone if an additional actor is not available.
- ED nurse can start IV and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed.
- Vascular or general surgeon can be available via "phone consultation."

Case narrative

Scenario background

A 58-year-old male presents after syncopal episode at work. He appears pale, and keeps his eyes closed, mumbling his answers to the learner's questions. His co-worker, who accompanied him to the hospital, states that the patient did not look well during a meeting that morning. He witnessed the patient become diaphoretic and pass out for a few seconds, leading him to call the ambulance.

Currently, the patient only complains of not feeling well and some pain in his right flank.

CC: Syncope.

PMH: Hypertension, hyperlipidemia, kidney stones.

Meds: Hydrochlorothiazide, simvastatin.

Allergies: None.

Family Hx: Unremarkable.

Social Hx: Smokes half a pack of cigarettes per day, occasional alcohol, no illicit drugs.

Initial scenario conditions

Middle-aged male, eyes closed, mumbling.

VS: Temp. 36 °C (96.9 °F), HR 100, RR 22, BP 98/66, O₂ sat 99% RA.

Fingerstick glucose test: 130.

Heart: Regular, no murmurs.

Lungs: Clear to auscultation.

Abdomen: Soft, non-distended, mild diffuse tenderness.

Extremities: Weak femoral and pedal pulses (may be prompted by the nurse), the toes on both feet appear cyanotic.

Skin: Diaphoretic.

Neurologic: Mumbles answers, not able to answer all questions, but does respond to pain when abdomen is palpated. He does move all extremities.

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners, e.g. the nurse can note weak lower extremity pulses. To make the patient appear diaphoretic, use spray glycerin liquid before the case.

See the flow diagram in Figure 2.3 for further scenario changes described below.

Case narrative, continued

The patient will become progressively ill, with worsening hypotension and decreased mental status. The learners' workup of syncope should include AAA as one of the top considerations. If needed, they can be prompted with additional cues such as physical findings of cyanosis in toes and decreased lower extremity pulses.

Once the diagnosis is made by ultrasound and/or CT or after 10 min if the diagnosis is not made or considered, the patient will decompensate into pulseless electrical activity, requiring resuscitation with medication, IV fluids, and blood. Note that images do not show rupture, so the CT image should only be shown if the patient is stable when it is ordered and would be able to be transported to obtain the study.

Once stabilized/resuscitated, the patient should be transferred to the care of a vascular surgeon for emergent surgical intervention.

For an additional learning opportunity for participants in this or any case, the patient can ask the learner to explain the diagnosis and what to expect after transfer or disposition from the emergency department.

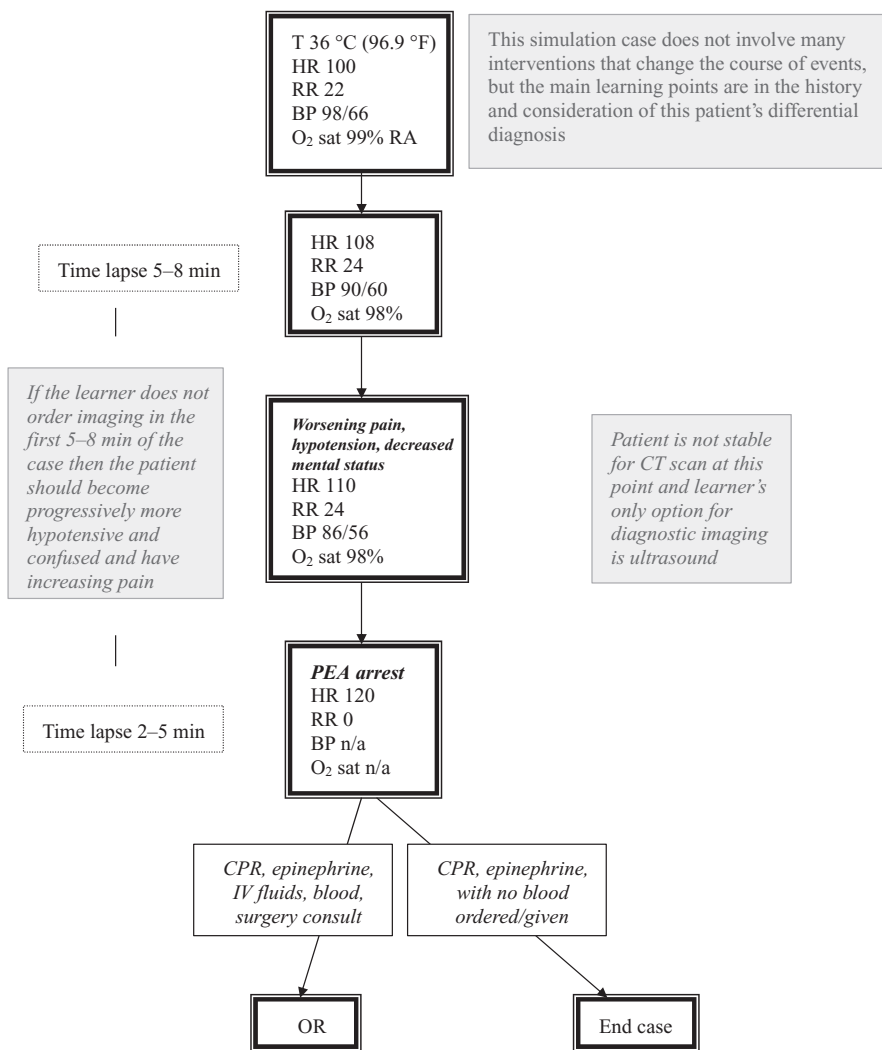


Figure 2.3 Scenario flow diagram: abdominal aortic aneurysm.

Instructor notes

Pathophysiology

- Pathologic dilatation of the abdominal aorta, which becomes life threatening if it leaks or ruptures:
 - Probability of rupture correlates with diameter of the aneurysm.
- Risk factors:
 - Atherosclerotic disease.
 - Tobacco use.
 - Hypertension.
 - Diabetes.
 - Inflammation or infection of aorta.
 - First-degree relative with the diagnosis.
 - Connective tissue diseases: Ehlers–Danlos and Marfan syndrome.

Clinical features

- Classic triad of ruptured AAA:
 - Pain.
 - Hypotension.
 - Pulsatile abdominal mass.
 - Patients rarely present with all three.
- Syncope, weakness, altered mental status, or other vague symptoms.
- Rarely, patients present primarily with scrotal, buttock, or hip pain.
- Physical examination:
 - Aortic pulsation to right of midline.
 - Left lower quadrant mass with tenderness and distension.
 - Absent or diminished lower extremity pulses.
 - Ruptured AAA may rarely cause a nerve compression:⁴
 - Femoral or obturator nerve may be compressed with retroperitoneal hemorrhage.
 - Anterior thigh pain with numbness associate with weakness of hip and knee flexion.

Diagnosis

- Ultrasound of the abdominal aorta:
 - Aortic diameter >3.0 cm combined with high clinical suspicion is diagnostic.
 - Can be limited due to body habitus or bowel gas.
 - Poor test for identifying leaking of the aneurysm.
- CT of the chest/abdomen/pelvis:
 - Diagnostic study of choice if patient is stable.
 - IV contrast shows leak, intra- or retroperitoneal blood.

Management

- IV fluids followed by blood products:

- Should be given immediately in the hemodynamically unstable patient.
- Typically 10 units of PRBCs should be typed and screened when high suspicion or confirmation of diagnosis.
- It is not clear how much fluid resuscitation should be done initially.³
- Urgent operative repair:
 - Indicated in acute rupture or leak of an AAA.
 - Considered in patients with aneurysmal pain without evidence of rupture or leak.
- Incidental findings of AAA <5.5 m in diameter may be observed and managed non-operatively with close surveillance.

Debriefing plan

Plan for ~30 min for discussion.

Potential questions for discussion

- What entities should be considered in the differential diagnosis for syncope?
- What are potential AAA misdiagnoses in the differential diagnosis for patients presenting with symptoms such as back pain, flank pain, hematuria?
- How might a retroperitoneal rupture of AAA differ in presentation from an intraperitoneal rupture of AAA?
- How aggressively should patients with ruptured AAA be fluid-resuscitated?
- Is IV contrast necessary for the CT scan?
- How should incidental findings of AAA be handled if discovered on ultrasound or CT scan?

Selected reading

1. Ernst C. Abdominal aortic aneurysm. *N Engl J Med* 1993;**328**:1167–1172.
2. Kuhn M, Bonnin R, Davey M, *et al.* Emergency department ultrasound scanning for abdominal aortic aneurysm: accessible, accurate, and advantageous. *Ann Emerg Med* 2000;**36**(3):219–223.
3. Haro L, Krajicck M, Lobl J. Challenges, controversies, and advances in aortic catastrophes. *Emerg Med Clin N Am* 2005;**23**:1159–1177.
4. Rogers R, McCormack, R Aortic disasters. *Emerg Med Clin N Am* 2004;**22**:887–908.

CHAPTER 3 **Resuscitation emergencies**

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Supraventricular tachycardia

Educational goals

Learning objectives

Primary:

1. Recognize supraventricular tachycardia (SVT) on ECG [*Medical Knowledge*].
2. Initiate appropriate therapy for SVT [*Patient Care, Medical Knowledge*].

Secondary:

1. Demonstrate good communication skills in working with nurse and consultants [*Interpersonal and Communication Skills, Professionalism*].
2. Demonstrate knowledge regarding the treatment and management of a patient with SVT [*Medical Knowledge, Patient Care*].

Critical actions checklist

- ☐ Assess airway, breathing, circulation (ABCs) [*Patient Care*]
- ☐ Place patient on cardiac monitor [*Patient Care*]
- ☐ Recognize SVT [*Medical Knowledge*]
- ☐ Administer adenosine [*Patient Care, Medical Knowledge*]
- ☐ Communicate the diagnosis and the treatment to the patient [*Interpersonal and Communication Skills, Professionalism*]

Emergency Medicine Simulation Workbook: A Tool for Bringing the Curriculum to Life, First Edition. Edited by Traci L. Thoureen and Sara B. Scott.

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Simulation set-up

Environment: Emergency department treatment area.

Mannequin: Simulator mannequin in hospital gown, sitting up on a stretcher, no monitoring or IV are in place. Simulator should be female.

Props: To be handed out or displayed on plasma screen/computer screen or to be distributed when the participants ask for results or when appropriate:

- Images (see the online component for Supraventricular Tachycardia, *Scenario 3.1.ppt*, at www.wiley.com/go/thoureen/simulation/workbook)
 - ECG with SVT.
 - SVT rhythm strip.
 - SVT rhythm strip with termination from adenosine administration.
 - Post-conversion 12-lead ECG showing sinus rhythm.
 - Chest X-ray report that is normal.
- Labs (see online component as above)
 - Fingertstick glucose test.
 - Complete blood count.
 - Complete metabolic panel.
 - Cardiac markers.
 - Coagulation panel.
 - Lactate.
 - D-dimer.
 - Urine pregnancy test.

Available in treatment room:

- Basic airway and code cart including defibrillator.
- Medications (labeled bags/syringes may be used in place of actual medicine syringes or bags):
 - Adenosine.
 - Diltiazem and/or verapamil (for advanced learners).
 - Metoprolol or other IV beta-blocker (for advanced learners).

Distractor: Nurse can act dismissive of the patient's presentation. She can whisper to the learner, "This patient is just anxious. She has been seen multiple times for this same thing and everything was normal."

Actors:

- Patient voice is female. Patient is able to provide her own history and should be interactive with the learner throughout the scenario.
- Nurse can start IVs, place the patient on the cardiac monitor, perform ECGs, and administer medications and fluids. The nurse may cue learners if needed and may act as a distractor if desired (see above).
- Cardiologist and/or primary care physician can be available by telephone.

Case narrative

Scenario background

A 23-year-old female presents with 2 h of palpitations. The patient states that she was cleaning the house when all of a sudden she felt her heart start to race. This has happened before, but only lasted a couple of minutes. She has been seen numerous times by both the emergency department and her primary care physician for this same complaint. This time, the sensation is not going away.

CC: Palpitations.

PMH: None.

Meds: None.

Allergies: None.

Family Hx: Mother has diabetes and father has hypertension.

Social Hx: No smoking, no alcohol, no drugs.

Initial scenario conditions

The patient is alert and oriented, able to give the history, but should sound uncomfortable due to palpitations during the interview.

VS: Temp. 37.2 °C (98.9 °F), HR 170, RR 18, BP 123/78, O₂ sat 99% on RA.

Eyes: Pupils equal, round, reactive to light.

Heart: Tachycardia with rate of 170.

Lungs: Clear to auscultation bilaterally.

Pulses: Present, equal, and rapid in all extremities.

Extremities: No peripheral edema.

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners, e.g. if your mannequin does not have reactive pupils you can verbally report the pupillary examination when it is requested.

See the flow diagram in Figure 3.1 for further scenario changes described below.

Case narrative, continued

The learner should order cardiac monitoring as well as an ECG. In addition, the learner may be required to order that an IV be established.

The patient will be relatively stable throughout the case. The patient should interact continuously with the learner, anxiously asking: “What is wrong with me?” This will help guide assessment of the learner’s medical knowledge and also gauge the learner’s interpersonal and professionalism skills.

If the learner attempts vagal maneuvers initially, they will not be successful. If electrical cardioversion is considered, cues can be given to steer the learner away from this action.

For students and junior learners, the administration of adenosine at an appropriate dose and in an appropriate manner will convert the rhythm. The patient should moan a little and become anxious during the adenosine administration.

For senior learners, the SVT can be resistant to adenosine and require rate control with beta-blockers or calcium channel blockers.

Although not essential to this case, the learner may order laboratory studies and/or a chest X-ray. The results of ordered studies should be withheld until after successful termination of the SVT.

After rhythm conversion, a disposition decision should be made. The actual disposition is not critical – the patient can either be admitted or discharged depending on the institutional culture. The disposition should be done in consultation with another physician. The patient can prompt the learner to call the primary care physician if needed. The learner’s medical knowledge can be assessed by questions from the consulting physician.

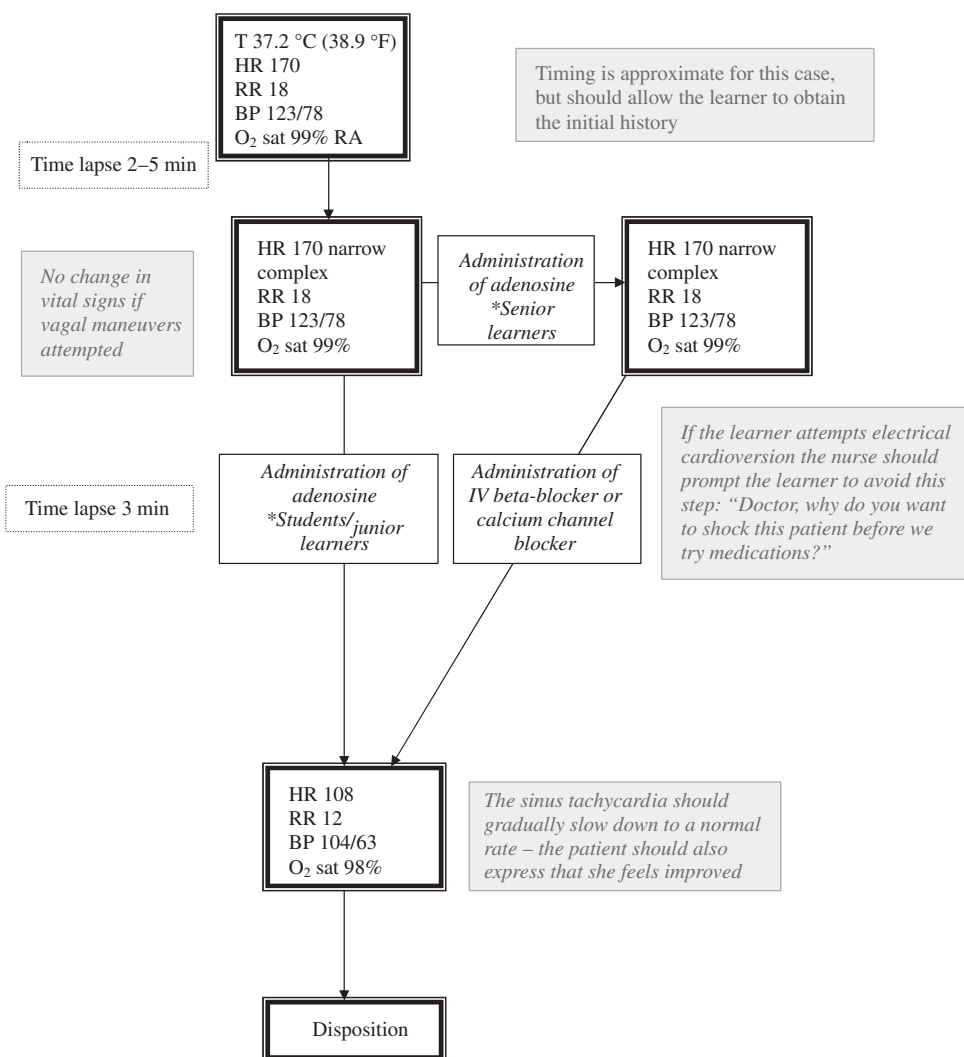


Figure 3.1 Scenario flow diagram: supraventricular tachycardia.

Instructor notes

Pathophysiology

- SVT is a generic term that refers to any tachyarrhythmia that originates above the ventricle:
 - Usually narrow complex with a regular, rapid rhythm.
 - Exceptions include atrial fibrillation (AF) and multifocal atrial tachycardia (MAT).
 - Aberrant conduction during SVT can result in a wide complex tachycardia.
- Paroxysmal SVT (PSVT) is due to an abnormal rhythm circuit that allows a wave of depolarization to travel repeatedly in a circle in cardiac tissue:
 - Typically episodic with abrupt onset.
 - Classified based on where the reentry circuit resides:
 - If both limbs of the re-entry circuit involve AV nodal tissue, then the PSVT that results is termed AV nodal re-entry tachycardia (AVNRT).
 - Alternatively, if one limb of the reentry circuit involves an accessory pathway and the other involves the AV node, then the PSVT that may result is termed AV re-entry tachycardia (AVRT).

Clinical features

- May be asymptomatic or may present with palpitations, lightheadedness, chest pressure, or more severe symptoms such as syncope.

Diagnosis

- PSVT is distinguished by a narrow complex tachycardia (rate usually >150 bpm) noted on the ECG.
- In the case of AVNRT, there are no P waves on the ECG or rhythm strip.

Management

- Recognize SVT and initiate measures to convert the rhythm to a sinus rhythm:
 - Vagal maneuvers may terminate PSVTs.
 - Adenosine should be used if PSVT does not respond to vagal maneuvers:
 - Initial dose is 6 mg rapid IV push through a large (e.g. antecubital) vein followed by a 20 mL saline flush. If the rhythm does not convert within 1–2 min, then dose can be increased to 12 mg IV push and repeated once.
 - Use second-line medications if adenosine unsuccessful:
 - Calcium channel blockers:
 - Verapamil 2.5–5 mg IV over 2 min and repeat doses of 5–10 mg may be given at 15 min intervals to a total dose of 20 mg.
 - Diltiazem 15–20 mg IV over 2 min, and if there is no response in 15 min, then 20–25 mg may be given followed by a maintenance infusion of 5–15 mg/h.
 - Beta-blockers:
 - Atenolol 5 mg IV over 5 min; repeat 5 mg in 10 min if arrhythmia persists or recurs.
 - Esmolol IV loading dose 500 µg/kg (0.5 mg/kg) over 1 min, followed by an infusion of 50 µg/kg/min (0.05 mg/kg/min). If response is inadequate,

infuse a second loading bolus of 0.5 mg/kg over 1 min and increase maintenance infusion to 100 µg/kg/min (0.1 mg/kg/min). Incrementally increase in this manner if required to a maximum infusion rate of 300 µg/kg/min (0.3 mg/kg/min).

- Metoprolol 5 mg over 1–2 min, repeated as required every 5 min to a maximum dose of 15 mg.
- Propranolol 0.5–1 mg over 1 min, repeated up to a total dose of 0.1 mg/kg if required.

Debriefing plan

Plan for ~30 min for discussion

Potential questions for discussion

- What are some key differences between ventricular tachycardia and SVT on the ECG?
- Other than adenosine, what agents are available for the treatment of PSVT?
- How would a PSVT with aberrancy appear on the ECG?
- How can you distinguish PSVT from some of the other narrow complex tachydysrhythmias?

Selected reading

1. Neumar RW, Otto CW, Link MS, *et al.* Part 8. Adult advanced cardiovascular life support: 2010 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation* 2010;**122**:S729–S767.
2. Kadish A, Passman R. Mechanisms and management of paroxysmal supraventricular tachycardia. *Cardiol Rev* 1999;**7**(5):254–264.

Bradycardia – third-degree heart block

Educational goals

Learning objectives

Primary:

1. Appropriately treat and manage symptomatic bradycardia [*Medical Knowledge*].
2. Demonstrate proficiency in using transcutaneous and/or transvenous pacing [*Patient Care, Medical Knowledge*].

Secondary:

1. Demonstrate good communication skills in working with ED nurses and calling consultants [*Interpersonal and Communication Skills, Professionalism*].

Critical actions checklist

- ☐ Assess airway, breathing, circulation (ABCs) [*Patient Care*]
- ☐ Place patient on cardiac monitor and pulse oximetry and obtain blood pressure [*Patient Care*]
- ☐ Obtain IV access, administer supplemental oxygen [*Patient Care*]
- ☐ Obtain fingerstick glucose test [*Medical Knowledge*]
- ☐ Obtain ECG and recognize third-degree heart block [*Medical Knowledge*]
- ☐ Administer medications for symptomatic bradycardia: atropine, dopamine, or epinephrine infusion [*Medical Knowledge*]
- ☐ Set up and initiate transcutaneous pacing. [*Patient Care, Medical Knowledge*]
- ☐ (Option: senior learners) Set up and initiate transvenous pacing. The setting up and initiation of transvenous pacing will depend on the equipment used in your department. [*Patient Care, Medical Knowledge*]
- ☐ Communicate with ICU /cardiologist for admission to critical care bed [*Interpersonal and Communication Skills*]

Simulation set-up

Environment: Emergency department treatment area.

Mannequin: Simulator mannequin in hospital gown, reclining on stretcher. No IV lines or monitors are applied. Simulator should be male. Option: (Senior Learners) Central line torso trainer for transvenous pacer placement.

Props: To be handed out or displayed when appropriate:

- Images (see online component for Bradycardia – Third-degree Heart Block, *Scenario 3.2.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG with third-degree heart block.
 - Chest X-ray report that is normal.
 - Rhythm strips showing third-degree heart block.
 - Rhythm strip of paced rhythm.
 - ECG of paced rhythm.
- Labs (see online component as above):
 - Fingerstick glucose test.
 - Complete blood count.
 - Complete metabolic panel.
 - Cardiac markers.
 - Coagulation panel.

Available in the treatment room:

- Basic airway and code cart.
- Pacing pads.
- Transvenous pacer and central line kit appropriate to your facility's resources.
- Medications (labeled bags/syringes may be used in place of actual medicine syringes or bags):
 - Atropine.
 - Dopamine infusion.
 - Epinephrine infusion.

Distractor: None.

Actors:

- Patient voice is male. Patient is drowsy but easily aroused and can answer simple questions but cannot provide a history of present illness.
- Patient's wife provides most of the history.
- ED nurse can start IV lines, administer medications and fluids, and cue learners if needed.
- Cardiologist/ICU physician can be available via "phone consultation."

For advanced learners, the specialist can be unavailable or refuse to admit the patient until transvenous pacing has been established.

Case narrative

Scenario background

A 62-year-old man was brought to the ED by his wife because he has been dizzy, weak, and drowsy all day. He has been intermittently dizzy over the past 2–3 weeks. He has generalized weakness and feels like he is going to pass out. He has intermittently felt like his heart was skipping beats.

History should be provided primarily by the patient's wife due to the patient's drowsiness.

CC: Generalized weakness, drowsiness.

PMH: Hypertension.

Meds: Hydrochlorothiazide, 50 mg daily.

Allergies: None.

Family Hx: Hypertension.

Social Hx: No smoking, occasional glass of wine, no drugs.

Initial scenario conditions

Patient is drowsy but easily aroused.

VS: Temp. 36.4 °C (97.5 °F), HR 39, RR 11, BP 81/51, O₂ sat 96% on RA.

Eyes: Closed but open to stimulation, pupils equal and reactive.

Heart: Bradycardic.

Lungs: Clear to auscultation bilaterally.

Pulses: Present.

Physical examination findings not available on your mannequin can be reported verbally, e.g. for mannequins without eye-blinking function, the nurse can state, "He finally opened his eyes for me in triage. His pupils were reactive on my examination."

See the flow diagram in Figure 3.2 for further scenario changes described below.

Case narrative, continued

The learner needs to ask the ED nurse to place the patient on a monitor. If the nurse is not asked to do so, she should prompt the learner about connecting the patient to monitors, administering IV fluids and oxygen, and obtaining blood work and an ECG. The ECG can be provided immediately, but any other imaging/laboratory work should be provided after the patient has been successfully paced.

The learner should begin treatment of the symptomatic bradycardia and may be prompted by the nurse if no action is taken. For all learners, atropine will not improve the vital signs. For students and junior learners, once transcutaneous pacing is initiated or epinephrine or dopamine infusion is started, vital signs should normalize and the learner should contact the cardiologist for admission to an ICU. Advanced learners need to address sedation for the patient when performing transcutaneous pacing. If no sedation is given, patient can wake up in pain from pacing and plead belligerently for the pacer to be turned off.

If your simulation equipment is unable to simulate transcutaneous pacing, the learner should verbalize the correct steps to this procedure. At a minimum, these steps should include correct placement of pacer pads, the initial amperage setting, the initial heart rate setting, and verbalizing what should be seen on the monitor with successful capture.

For senior learners, the IV vasopressors and transcutaneous pacer should not change the vital signs and the learner should initiate the process of transvenous pacing using your site's standard central line and transvenous pacer equipment. Depending on your mannequin's capabilities, a second mannequin or central line simulator torso can be used for simulation of central line placement. The ED nurse can ask the learner questions during the process of placing the pacer to assess the learner's knowledge. The learner should contact the cardiologist and admit the patient to the ICU upon successful placement of the pacer.

If your simulation equipment is unable to simulate transvenous pacing, the learner should verbalize the correct steps of the procedure. At a minimum, these steps should include verbalizing when to inflate and deflate the pacer balloon, the initial amperage setting, the initial heart rate setting, and the rhythm that should be seen on the monitor as the pacer tip approaches the atrium, enters the atrium, enters the ventricle, and successfully captures the rhythm.

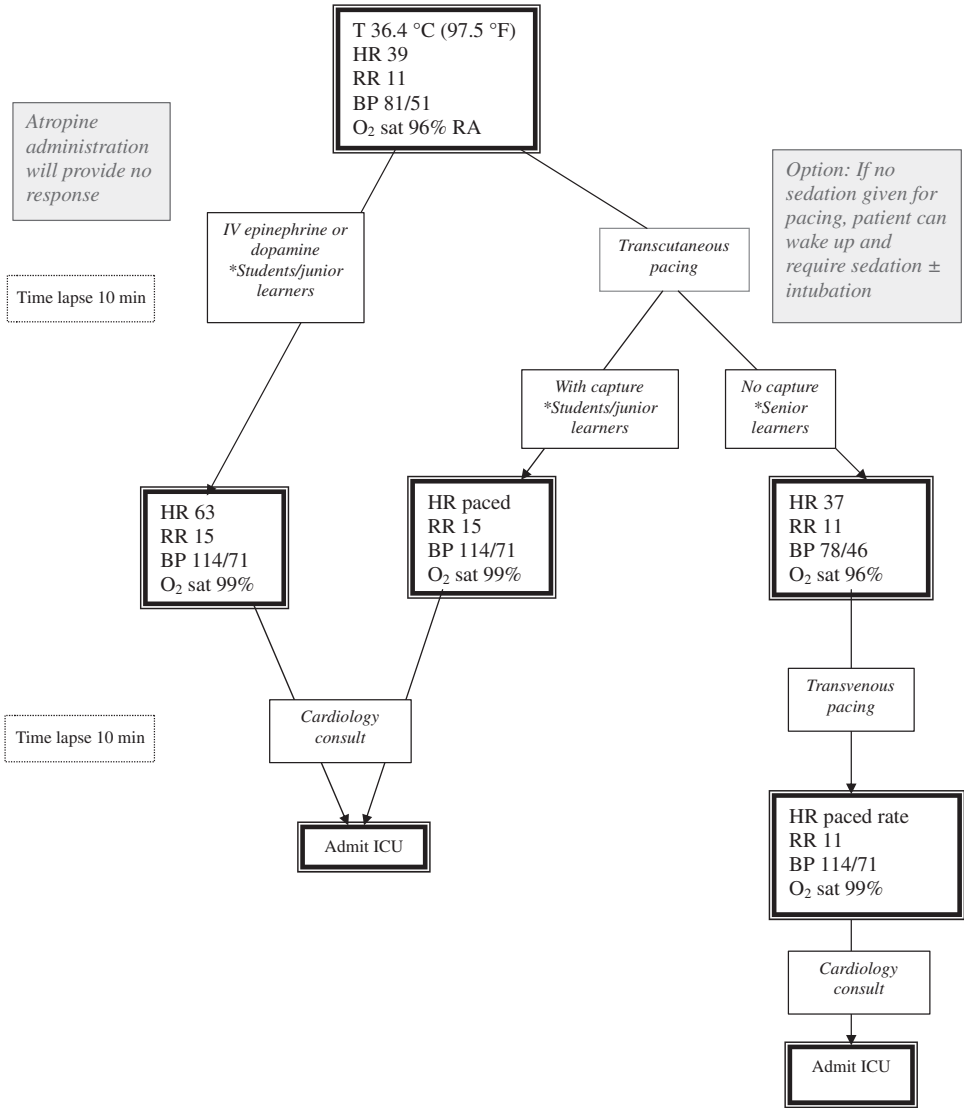


Figure 3.2 Scenario flow diagram: third-degree heart block.

Instructor notes

Note that current management guidelines for bradycardia should be reviewed for your discussion of this topic

Pathophysiology

- Third-degree heart block occurs when there is no conduction through the atrioventricular (AV) node.
- Third-degree heart block can have multiple causes, including the following:
 - Myocardial ischemia.
 - Medications such as calcium channel blockers, beta-blockers, digoxin.
 - Metabolic abnormalities such as hyperkalemia.

Clinical features

- Often presents with associated hypotension.
- Other common symptoms include chest pain, syncope, decreased level of consciousness, fatigue, dizziness, and weakness.

Diagnosis

- No atrial impulses are able to reach the ventricle.
- The ECG shows dissociation between the P waves and ventricular QRS.
- The QRS complex may be narrow or wide, depending on whether the escape rhythm is coming from a supraventricular or ventricular site.

Management

- Atropine, 0.5 mg IV, up to 3 mg total. It is not uncommon for atropine to be unsuccessful at altering wide complex escape rhythms.
- Transcutaneous pacing:
 - Sedate prior to pacing if possible.
- Continuous infusions of a chronotropic agent (dopamine or epinephrine) can be used as an alternative to transcutaneous pacing.
- Transvenous pacing.
- Isoproterenol infusion may be considered.
- Treatment of underlying cause:
 - Reperfusion.
 - Antidotes for medication overdoses.
 - Correction of metabolic or electrolyte disturbances.

Debriefing plan

Allow ~15 min for discussion.

Potential questions for discussion

- What is the general management of symptomatic bradycardia?
- What are the different types of AV block?
- What are the most common causes of third-degree AV block?

- How are transcutaneous and transvenous pacers initiated and monitored to make sure that they are functioning effectively?

Selected reading

1. Brady WJ Jr. Diagnosis and management of bradycardia and atrioventricular block associated with acute coronary ischemia. *Emerg Med Clin North Am* 2001;**19**:371–384.
2. Mangrum JM. The evaluation and management of bradycardia. *N Engl J Med* 2000;**342**:703–709.
3. Bessman ES. Emergency cardiac pacing. In: Roberts JR, Hedges JR, eds. *Clinical Procedures in Emergency Medicine*, 4th edn. Philadelphia: Saunders, 2004, pp. 283–304.

Ventricular tachycardia/therapeutic hypothermia

Educational goals

Learning objectives

Primary:

1. Understand and recognize the differences between stable ventricular tachycardia (VT), unstable VT, and pulseless VT [*Medical Knowledge*].
2. Initiate appropriate therapy for unstable VT [*Patient Care, Medical Knowledge*].
3. Understand the treatment and management of post-cardiac arrest patients [*Medical Knowledge*] (*senior-level learners).
4. Implement therapeutic hypothermia in a post-cardiac arrest patient [*Patient Care, Medical Knowledge*] (*senior-level learners).

Secondary:

1. Demonstrate good communication skills in working with nurses and consultants [*Interpersonal and Communication Skills*].
2. Initiate appropriate treatment and management of a patient with acute coronary syndrome [*Medical Knowledge*].

Critical actions checklist

- ☐ Assess airway, breathing, circulation (ABCs) [*Patient Care*]
- ☐ Recognize unstable VT [*Medical Knowledge*]
- ☐ Perform synchronized cardioversion without delay [*Patient Care, Medical Knowledge*]
- ☐ Recognize signs of myocardial ischemia on initial/post cardiac arrest ECG [*Medical Knowledge*]
- ☐ Administer aspirin [*Medical Knowledge*]
- ☐ Call and communicate with cardiology for disposition [*Interpersonal and Communication Skills, Professionalism*]

Optional add-ons when Phase II is used:

- ☐ Perform intubation for airway protection and respiratory failure [*Patient Care, Medical Knowledge*]
- ☐ Initiate therapeutic hypothermia using multiple active cooling methods including ice packs, cold saline, and gastric lavage (or standard methods at your institution) [*Medical Knowledge, Patient Care*]
- ☐ Ensure placement of a core body temperature probe [*Medical Knowledge*]
- ☐ Administer sedation and paralytics to prevent shivering [*Medical Knowledge, Patient Care*]

Simulation set-up

Environment: Emergency department treatment area.

Mannequin: Simulator mannequin in hospital gown, lying flat on stretcher, attached to cardiac monitor, pulse oximetry, and blood pressure cuff, with peripheral IV line in place. Simulator is male. Optional central line torso trainer can also be in the room for senior learners who will need to progress to initiating therapeutic hypothermia and place a central line.

Props: To be handed out or displayed on plasma screen/ computer when appropriate:

- Images (see the online component for Ventricular Tachycardia/Therapeutic Hypothermia, *Scenario 3.3.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG with anterolateral ST depressions (this may be shown as both initial ECG and post-cardioversion).
 - VT rhythm strip.
 - VT 12-lead ECG.
 - Chest X-ray report noting cardiomegaly.
 - Rhythm strip showing ventricular fibrillation (VF).
 - Report of post-intubation chest X-ray that shows that the endotracheal tube (ETT) is in a good position.
- Labs (see online component as above):
 - Fingerstick glucose test.
 - Complete blood count.
 - Complete metabolic panel.
 - Cardiac markers.
 - Lactate.
 - Coagulation panel.

Available in the treatment room:

- Basic airway and code cart, including defibrillator.
- Medications (labeled bags/syringes may be used in place of actual medicine syringes or bags):
 - Amiodarone.
 - Lidocaine.
 - Procainamide infusion.
 - Epinephrine.
 - Heparin infusion.
 - Nitroglycerin spray, 0.4 mg (the simulator's lubricant bottle can be labeled as sublingual spray).
 - Aspirin.
 - Rapid sequence intubation medications: paralytic and sedative agents typically used at your institution.
 - Liter bags of 0.9% normal saline (NS) or lactated Ringer's (LR).

Additional items for Phase II (optional):

- Ice packs, cold bags of saline.

Bags of rock salt can be used to simulate ice packs to avoid exposing the simulator to water. Cold saline infusions can be simulated with large labels on normal saline bags.

- External cooling pads or your facility's equivalent.
- Endovascular cooling device (if used at your facility).
- Core temperature probe

Distractor: None.

Actors:

- Patient voice is male. Patient is able to provide his own history.
- Nurse can start IV lines, administer medications and fluids, and cue learners if needed.
- Cardiologist can be available via "phone consultation."

Case narrative

Scenario background

A 48-year-old man presents after experiencing 6 h of substernal chest pain, which is radiating to his left arm. He describes the pain as a pressure sensation, and it is associated with nausea and shortness of breath. The pain started to decrease when the patient sat down in the waiting room, but it is still present.

CC: Chest pain.

PMH: Hypertension, hyperlipidemia.

Meds: Metoprolol, simvastatin.

Allergies: None.

Family Hx: Hypertension, coronary artery disease, brother with first MI at 44 years of age.

Social Hx: Quit smoking 3 years ago, no alcohol, no drugs.

Initial scenario conditions

Uncomfortable-appearing middle-aged male.

VS: Temp. 37.3 °C (99.1 °F), HR 96, RR 15, BP 156/92, O₂ sat 99% on RA.

Eyes: Pupils equal, round, reactive to light.

Heart: Normal S1 and S2, no murmur.

Lungs: Clear to auscultation bilaterally.

Pulses: Present and equal in all extremities.

Extremities: No peripheral edema.

See the flow diagrams in Figures 3.3 and 3.4 for further scenario changes described below.

Case narrative, continued

The patient should be connected to the monitor at the start of the case and should provide adequate background history to direct the learner towards a diagnosis of acute coronary syndrome. The learner should order an ECG, complete blood count, metabolic panel, and assessment of cardiac markers typically obtained in your facility. The nurse can prompt the learner to order the studies, if necessary. ECG can be provided immediately, the lab results should be withheld until after cardioversion.

After about 5 min or completion of the tasks described above, the patient's rhythm suddenly deteriorates into monomorphic ventricular tachycardia with weak peripheral pulses. The patient is to state, "I don't feel well," and then fades out of consciousness.

The learner should be alerted to the rhythm change immediately by the nurse and/or by monitor alarms. He or she is expected to recognize quickly unstable VT and the need for immediate synchronized cardioversion.

- If chest compressions are started, the patient is to wake up in response to the pain of the compressions but quickly lose consciousness again.
- If anti-arrhythmics are started, no effect is seen.
- If the learner does not cardiovert, he or she can be prompted to do so by the nurse. The learner should either cardiovert the patient himself or herself or direct the nurse to do the procedure.
- If the nurse is directed to cardiovert the patient, the learner must give clear instructions on how to do cardioversion and the number of joules to be used.
- If no electricity, <100 J used, or unsynchronized cardioversion (defibrillation) performed, the patient is to deteriorate into ventricular fibrillation (VF).

Once appropriate cardioversion has been applied, the patient converts to sinus tachycardia. Any ordered labs/imaging can return at this time. Learners should consult cardiology, who will plan to take the patient to the cardiac cath. lab. For students/junior learners, the case can end here.

For senior learners, the patient decompensates to VF while awaiting transfer to the cardiac cath. lab. VF should be quickly recognized and defibrillated. If defibrillation is not performed within 3 min, the case ends and proceeds to debriefing.

Following successful defibrillation, the learner should recognize the need for advanced airway placement, intubate immediately, and give appropriate ventilator settings. If the patient is not intubated, the respirations should trend towards zero and O₂ saturation should trend towards 70%. If the learner does not intubate the patient, the nurse should cue the learner to do so.

After completion of the tasks described above, the learner should initiate therapeutic hypothermia for this post-cardiac arrest patient. The nurse can prompt the learner: "This guy is so young. Do you think there was any brain damage? Can we do anything to prevent a poor neurologic outcome?"

The learner should initiate at least two or three methods of active cooling, depending on your facility's normal protocols. These can include ice packs, cold saline infusions, cooling blankets, endovascular cooling, and lavage.

Endovascular cooling can be simulated by using a separate central-line torso nearby to simulate line placement and equipment setup. The cooling equipment should not be turned on while it is on the mannequin. To avoid damage, check with the manufacturer before integrating cooling protocols with the simulation equipment.

A core temperature probe should be requested with the measurement displayed on the monitor. The learner should order sedation and paralytics to prevent shivering. If paralytics are not given, the nurse can prompt the learner and shake the bed gently to simulate shivering. Once cooling measures have been instituted correctly, the simulated temperature should drop consistently with your equipment's typical rate of cooling.

If a post-arrest ECG, if obtained, it would again show anterolateral ST depression. The learner should contact the cardiologist for admission and can be prompted to do so by the ED nurse.

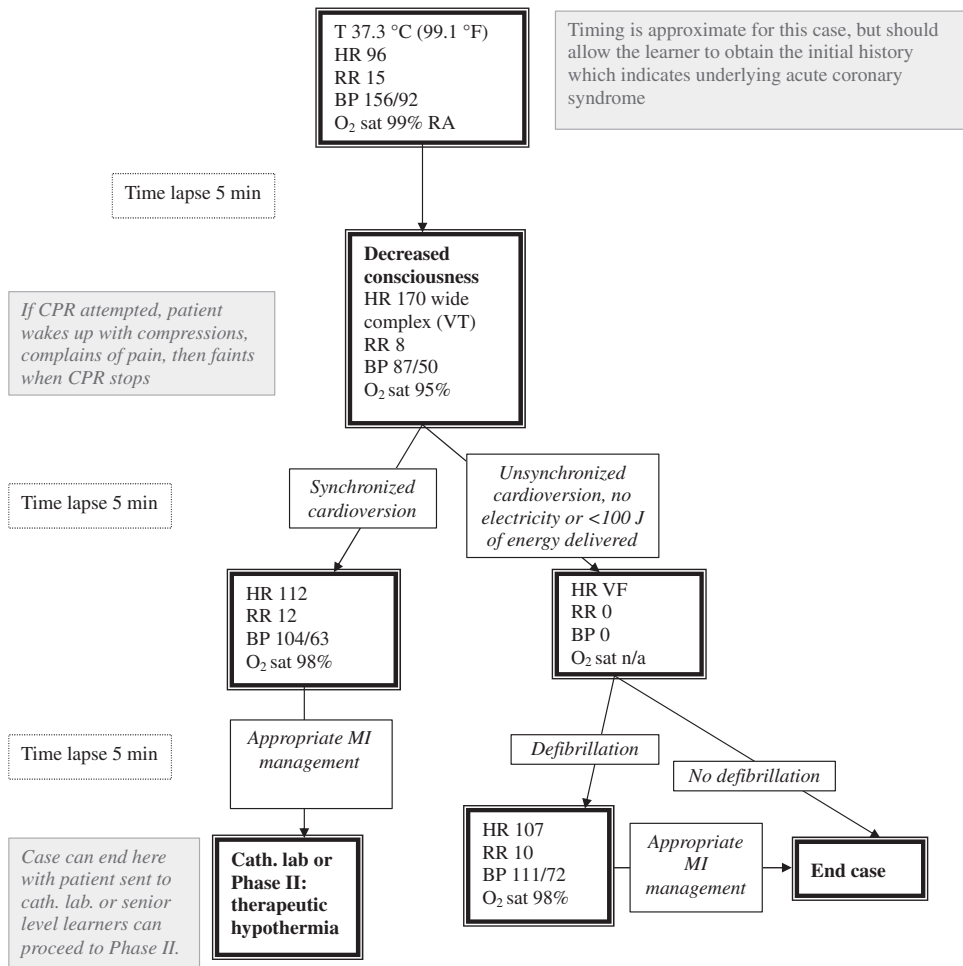


Figure 3.3 Scenario flow diagram: VT/therapeutic hypothermia flow diagram, Phase I.

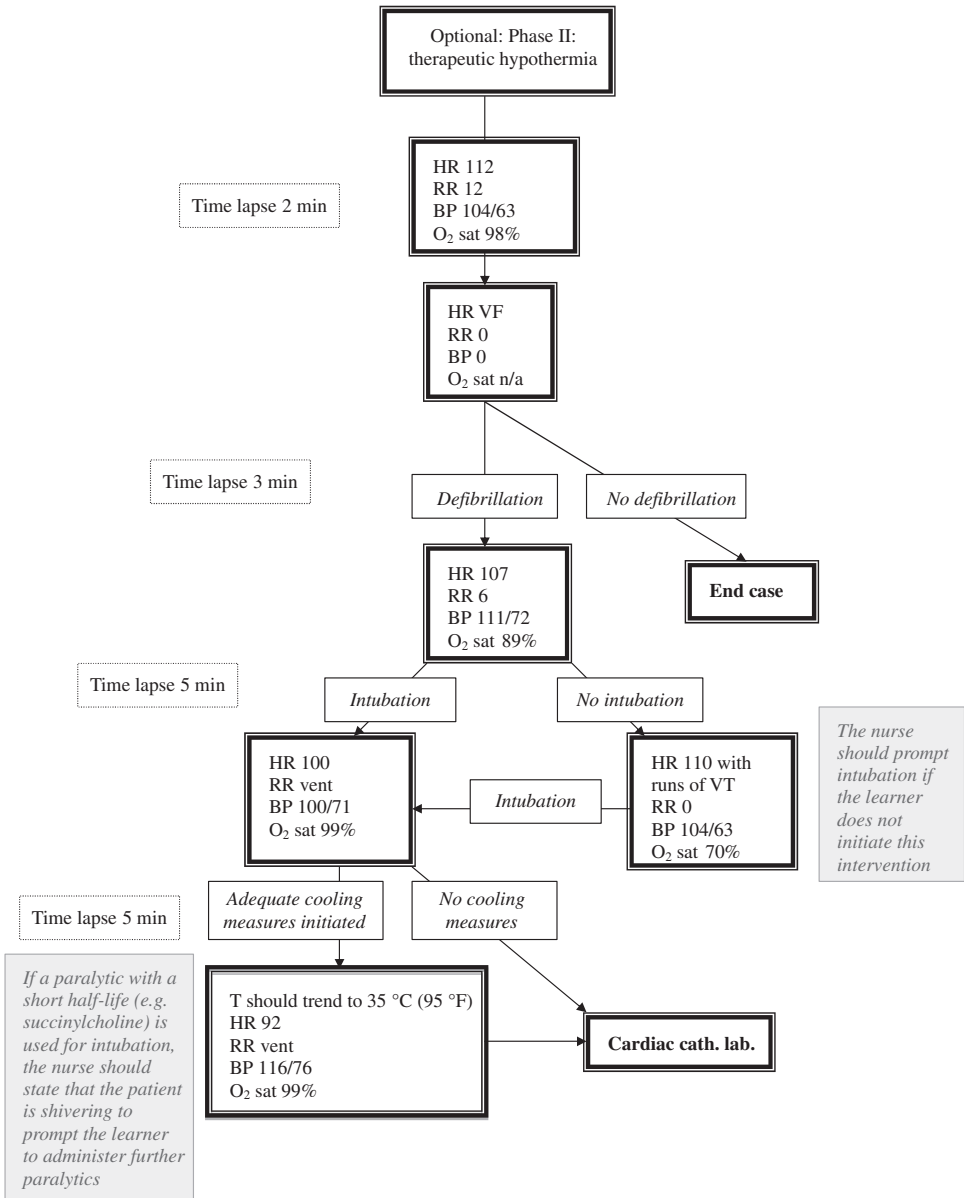


Figure 3.4 Scenario flow diagram: VT/therapeutic hypothermia flow diagram, Phase II (optional).

Instructor notes

Pathophysiology

- VT is a tachydysrhythmia that originates from an ectopic focus in the ventricular system.
- During VT, the ventricles are in a state of constant stimulation:
 - Stroke volume ↓ secondary to decreased filling time and impaired relaxation.
 - Cardiac output ↓ because of decreased stroke volume.
 - Myocardial perfusion ↓ because of hypotension and impaired relaxation.
 - Myocardial oxygen demand ↑ as a result of tachycardia.
- VT has two forms: monomorphic and polymorphic.
 - Polymorphic is often associated with ischemic heart events or electrolyte or toxic conditions (e.g. torsades de pointes).

Clinical features

- VT may present in several ways:
 - Stable VT is defined as asymptomatic or with minimal symptoms, such as palpitations.
 - Unstable VT is defined as VT with pulses present, but symptoms consistent with hypoperfusion such as hypotension, altered mental status, and chest pain.
 - Pulseless VT is defined as VT without pulses present.

Diagnosis

- Monomorphic VT:
 - ECG showing QRS complexes of >120 ms that are regular and have atrioventricular (AV) dissociation. The heart rate is >100 bpm and more often >120 bpm.
- Polymorphic VT
 - ECG with wide complexes (as above) with variable QRS morphology.

Management

- Recognize unstable VT and initiate cardioversion as quickly as possible.
 - For monomorphic VT, cardioversion should be synchronized to prevent an R-on-T phenomenon:
 - 100 J for both monophasic and biphasic devices.
 - Subsequent shocks can be at equal or higher energy if repeat cardioversion is required.
 - Polymorphic VT generally requires defibrillation:
 - 200 J biphasic or 360 J monophasic.
 - Magnesium 1–2 g in 10 mL of 5% dextrose in water (D5W) over 1–2 min.
- Sedation should be considered prior to cardioversion based on the clinical scenario.
- Antiarrhythmics are not part of the ACLS algorithm for unstable VT but are helpful in stable VT and should be considered after cardioversion to prevent recurrence:
 - Amiodarone (150 mg over 10 min, followed by infusion of 1 mg/min × 6 h, then 0.5 mg/min. Total dose/24 h. should not exceed 2.2 g).

- Procainamide (20–50 mg/min until arrhythmia suppressed, hypotension ensues, or QRS prolonged by 50%, or total cumulative dose of 17 mg/kg. May also give 100 mg dose every 5 min until arrhythmia is controlled or other conditions described above are met).
- Sotalol (1.5 mg/min over 5 min. Note U.S. packaging recommends any dose infusing over 5 h).
- Magnesium (in patients with long QT) (1–2 g over 15 min).
- Admission to cardiac care unit (CCU) or intensive care unit (ICU).

Therapeutic hypothermia post-cardiac arrest

Background

- Patient selection:
 - Comatose patients with return of spontaneous circulation after cardiac arrest, particularly following ventricular fibrillation or ventricular tachycardia.
- Timing:
 - Initiate as early as possible following return of spontaneous circulation.

Pathophysiology

- Decreases tissue damage (i.e. ischemic injury and subsequent reperfusion injury).
- Reduces cerebral oxygen demand by reducing cerebral metabolism.
- Inhibits inflammatory and apoptotic signaling molecules.
- Decreases free-radical production and lipid peroxidation.
- Repairs the blood–brain barrier.
- Restores normal intracellular signaling and gene expression.
- Increases the likelihood of a good neurologic outcome and decreases the risk of death for patients with out-of-hospital cardiac arrest and return of spontaneous circulation.

Management

- Contraindications:
 - Drug overdose or other toxicity that could cause a comatose state.
 - Major surgery within the past 2 weeks.
 - Evidence of sepsis or ongoing infection.
 - Refractory cardiogenic shock.
 - Patients with known coagulopathy.
- Active cooling measures:
 - Cold IVF.
 - Ice packs.
 - Cooling blankets.
 - Endovascular cooling.
- Paralytics should be used to prevent shivering.
- Complications:
 - Seizures, hypokalemia, coagulopathy, cardiac dysrhythmias.

Debriefing plan

Allow ~30 min for discussion.

Potential questions for discussion

- What is the difference between stable VT, unstable VT, and pulseless VT?
- What is the treatment algorithm for unstable VT?
- What are the defibrillator settings for unstable VT?
- What are the most common causes of VT and VF?
- What are the indications for induced hypothermia? What are the benefits?
- What are the contraindications to induced hypothermia?
- What methods of cooling are available?
- Why is paralysis important when cooling a patient?

Selected reading

1. Dancy M, Ward D. Diagnosis of ventricular tachycardia: a clinical algorithm. *BMJ* 1985;**291**: 1036–1038.
2. Bernard SA, Gray TW, Buist MD, *et al.* Treatment of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia. *N Engl J Med* 2002;**346**:557–563.
3. Hypothermia after Cardiac Arrest Study Group. Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest. *N Engl J Med* 2002;**346**:549–556.
4. Neumar RW, Otto CW, Link MS, *et al.* Part 8. Adult advanced cardiovascular life support: 2010 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation* 2010;**122**:S729–S767.
5. Peberdy MA, Callaway CW, Neumar RW, *et al.* Part 9. Post-cardiac arrest care: 2010 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation* 2010;**S768**–S786.

CHAPTER 4 **Gastrointestinal emergencies**

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Esophageal perforation (Boerhaave's syndrome)

Educational goals

Learning objectives

Primary:

1. Recognize signs and symptoms of esophageal perforation [*Medical Knowledge, Patient Care*].
2. Consider esophageal perforation in the differential diagnosis of a patient with chest pain [*Medical Knowledge*].
3. Initiate management of a patient with a perforated esophagus [*Medical Knowledge, Patient Care*].

Secondary:

1. Demonstrate effective leadership of a treatment team in the emergency department setting [*Interpersonal and Communication Skills, Professionalism*].
2. Direct proper disposition/appropriate consultation [*Systems-Based Practice*].

Critical actions checklist

- ☐ Assess airway, breathing, and circulation (ABCs) [*Patient Care*]
- ☐ Obtain concise history of vomiting and chest pain [*Patient Care, Medical Knowledge*]
- ☐ Perform focused physical examination of a patient with vomiting and chest pain [*Patient Care, Medical Knowledge*]
- ☐ Order electrocardiogram (ECG) and chest X-ray to evaluate causes of chest pain [*Medical Knowledge*]
- ☐ Identify mediastinal air on chest X-ray [*Medical Knowledge*]
- ☐ Initiate broad-spectrum antibiotics [*Medical Knowledge, Patient Care*]
- ☐ Consult cardiothoracic surgery for definitive management [*Medical Knowledge, Systems-based Practice*]
- ☐ Present patient to consultant politely, thoroughly, and concisely [*Interpersonal and Communication Skills, Professionalism*]

Critical actions can be changed to address the educational needs and level of the learner. For example, medical students may be expected only to identify the problem, and may not be expected to know the appropriate management or admitting service; senior learners should be expected to manage the entire case without difficulty.

Emergency Medicine Simulation Workbook: A Tool for Bringing the Curriculum to Life, First Edition. Edited by Traci L. Thoureen and Sara B. Scott.

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Simulation set-up

Environment: Emergency Department (ED) treatment area.

Mannequin: Simulator mannequin, no moulage, on a stretcher or hospital bed. Mannequin may be male or female.

If moulage is desired, consider a mixture of oatmeal and green food coloring on the clothing and/or around the mouth to simulate vomitus.

Props: To be displayed on plasma screen/computer screen or printed out on handouts in the scenario room when asked for/return from laboratory:

- Images (see online component for Esophageal Perforation (Boerhaave's Syndrome), *Scenario 4.1.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG with sinus tachycardia.
 - Chest X-ray that shows pneumomediastinum with right-sided pneumothorax.
 - Esophageal contrast study showing a large perforation in the mid-esophagus.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Hepatic function panel.
 - Cardiac enzymes.
 - Lipase.

Available in the treatment room:

- Cardiac monitor with ECG leads, blood pressure cuff, and pulse oximeter.
- Nasal cannula (NC) and non-rebreather mask (NRB) for supplemental oxygen.
- Medications (labeled bags/syringes may be used in place of actual medicine syringes or bags):
 - Intravenous fluids (IVFs): normal saline (NS) and 5% dextrose in water (D5W).
 - Full complement of vasoactive agents.
 - Advanced cardiac life support (ACLS) medications.
 - Sedatives.
 - Induction and paralytic agents for rapid sequence intubation (RSI).
 - Analgesics.
 - Broad-spectrum antibiotic(s).
- Code cart with defibrillator available for use.
- Supplies for direct laryngoscopy and intubation.

Distractor: None.

Actors:

- Patient voice is male or female. Patient sounds somewhat uncomfortable, but is alert and oriented.

- ED nurse can start intravenous lines (IVs) and administer medications/fluids. The nurse does have some medical knowledge and may cue learners if needed.
- Pharmacy available via “phone consultation.” Option: to increase difficulty you can make pharmacy unavailable.
- Cardiothoracic surgeon can be available via “phone consultation.”

Case narrative

Scenario background

A 46-year-old male/female presents ambulatory to the ED with chest pain. The pain has been worsening for several hours. Says it is worse with deep breaths, but denies shortness of breath. Nothing seems to relieve it. The patient first noticed the pain this morning right after waking. Last night, he/she drank too much at a holiday party and vomited several times (non-bloody, non-bilious). Denies any leg swelling, abdominal pain, or chills.

Depending on the level of the learner, more or less history can be initially given. More advanced learners can be expected to perform a more complete history, so less information can be given up front.

CC: Chest pain.

PMH: Hypertension, diabetes, hypercholesterolemia.

Meds: Hydrochlorothiazide, simvastatin, aspirin, metformin.

Depending on the level of the learner, this medical history can be modified. For instance, this patient has risk factors for coronary artery disease that can be removed for more novice learners, for whom you may desire less distracting information.

Allergies: None.

Family Hx: Unremarkable.

Social Hx: No smoking, occasional alcohol, no illicit drugs.

Initial scenario conditions

Alert, uncomfortable male/female.

VS: Temp. 37.7°C (99.9°F), HR 123, RR 19, BP 156/89, O₂ sat 97% RA.

Head, eyes, ears, nose, throat: Head normocephalic and atraumatic, pupils equal, round, and reactive to light, extraocular movements intact, no lymphadenopathy, normal oropharynx, mucous membranes somewhat dry.

Heart: Tachycardia, no murmurs.

Lungs: Slightly diminished breath sounds on the right, clear to auscultation on the left, no crackles, wheezes, or rales.

Abdomen: Soft, non-tender, non-distended. Rectal examination hemoccult negative.

Extremities: No edema or rashes.

Neurologic: Normal.

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners, e.g. the rectal examination can be verbally reported by the nurse when it is requested.

See the flow diagram in Figure 4.1 for further scenario changes described below.

Case narrative, continued

During the initial 5 min of the case, the patient remains relatively stable while the learner obtains the history, performs a physical examination, and places initial orders. The patient develops a fever, the heart rate should increase slightly, and the blood pressure should decrease slightly during this time.

During the next 5 min, the learners will receive the results of initial studies. The learners should identify a pneumothorax on the chest X-ray and diagnose a likely esophageal perforation/Boerhaave's syndrome. Treatment with IVFs and antibiotics should be initiated. If this course of action is taken, the patient's pneumothorax does not develop tension physiology as evidenced by improving HR and stabilized BP.

If the learners initiate treatment that would be more appropriate for acute coronary syndrome or another cardiovascular emergency, the patient's condition will worsen. This will likely take the form of missed diagnosis of pneumothorax and administration of aspirin, nitroglycerin, etc., with lack of IVFs and antibiotics. The HR will increase and the BP will decrease until the patient is clearly exhibiting tension physiology and is now somnolent.

At this point, the learners should re-evaluate the patient and should recognize tension pneumothorax, appropriately treating with needle decompression/tube thoracostomy. If this is not performed, PEA develops, which can only be treated with decompression/tube thoracostomy. Once decompression has been performed, the patient's vital signs will normalize.

Once the patient has been stabilized, the learner should consult an admitting cardiothoracic surgeon for admission to the ICU and subsequent operative repair.

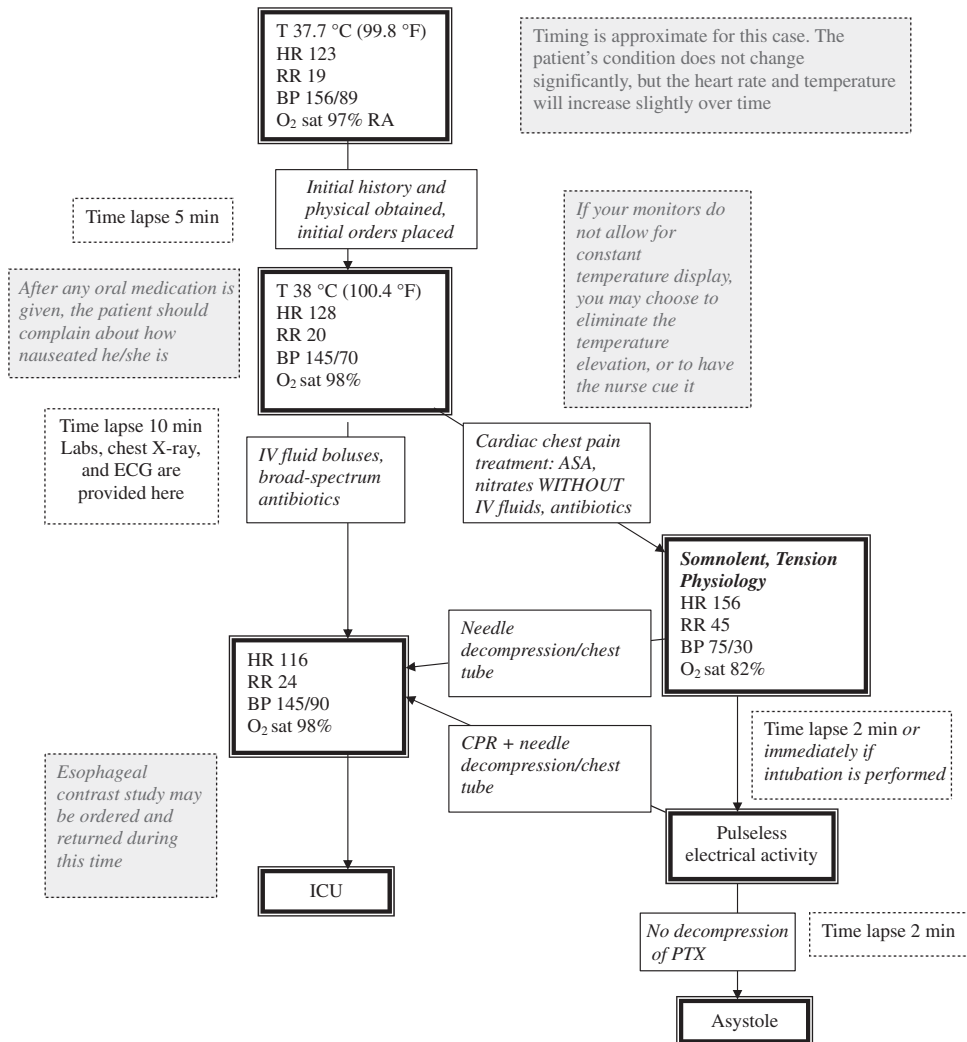


Figure 4.1 Scenario flow diagram: Boerhaave's syndrome.

Instructor notes

Pathophysiology

- Boerhaave's syndrome results from a rapid intraluminal pressure increase in the esophagus, often due to vomiting → complete tear in the esophageal lining and leakage of intraluminal contents into the mediastinal and/or pleural space.
- Boerhaave's syndrome is frequently associated with ingestion of large amounts of food and alcohol.
- Esophageal perforation from other causes (iatrogenic, foreign body) is somewhat less likely to result in early mediastinitis, as gastric contents are not forcibly introduced to the mediastinum.

Clinical features

- Most commonly presents as sudden-onset chest pain after vomiting.
- Easily confused with myocardial infarction, aortic dissection, gastric ulcer, and other causes of similar symptoms.
- Physical findings are variable, with the "classic" presentation consisting of hypotension, tachycardia, and tachypnea.
- Subcutaneous emphysema may be present.
- If patient presents early, physical findings may be normal.

Diagnosis

- Requires adequate suspicion.
- Esophageal rupture must be included in the differential for chest pain, especially when there is a history of emesis.
- 90% of patients have a left-sided pleural effusion or hydropneumothorax, but right-sided perforation is possible.
- Upright radiographs of the esophagus with either water-soluble or barium contrast will show the site of perforation:
 - If water-soluble is performed first, and negative, barium should be performed next.
- Computed tomography (CT) diagnosis is also an option.

Management

- Fluid resuscitation.
- Broad-spectrum antibiotics.
- Analgesics.
- If hemodynamic effects are present due to increased intrathoracic pressure from pneumothorax, emergent tube thoracostomy should be performed.
- Requires surgical repair, so early consultation with cardiothoracic surgery is mandated.

Debriefing plan

Plan for ~30 min for discussion.

Potential questions for discussion

- What are the most common causes of esophageal perforation?
- What findings on CXR make one suspicious of esophageal perforation?
- What is the difference between a Mallory–Weiss tear and Boerhaave’s syndrome?
- What are the life-threatening outcomes of esophageal perforation?
- What are the mainstays of ED therapy for esophageal perforation?
- What test might be indicated to evaluate the site of the tear?

Selected reading

1. Bjerke HS. Boerhaave’s syndrome and barogenic injuries of the esophagus. *Chest Surg Clin N Am* 1994;4:819–825.
2. Griffin SM, Lamb PJ, Shenfine J, *et al.* Spontaneous rupture of the oesophagus. *Br J Surg* 2008;95:1115–1120.
3. Sepesi B, Raymond DP, Peters JH. Esophageal perforation: surgical, endoscopic and medical management strategies. *Curr Opin Gastroenterol* 2010;26:379–383.

Intestinal perforation

Educational goals

Learning objectives

Primary:

1. Assess a patient with acute abdominal pain [*Patient Care*].
2. Formulate a differential diagnosis for acute abdominal pain [*Medical Knowledge*].
3. Pursue an initial workup for patient, including upright abdominal or chest X-ray [*Medical Knowledge, Patient Care, Systems-based Practice*].

Secondary:

1. Demonstrate professionalism and communication skills in dealing with a difficult patient [*Interpersonal and Communication Skills, Professionalism*].
2. Direct proper disposition/appropriate consultation [*Systems-based Practice*].

Critical actions checklist

- ☐ Assess airway, breathing, and circulation [*Patient Care*]
- ☐ Obtain a concise history of sudden onset pain [*Patient Care*]
- ☐ Provide prompt pain relief [*Patient Care*]
- ☐ Order upright chest X-ray and/or abdominal X-ray [*Medical Knowledge*]
- ☐ Correctly interpret radiographs [*Medical Knowledge*]
- ☐ Appropriately communicate with an angry patient [*Interpersonal and Communication Skills, Professionalism*]
- ☐ Call and communicate to general surgery for disposition [*Interpersonal and Communication Skills, Professionalism*]

Simulation set-up

Environment: ED treatment area.

Mannequin: Simulator mannequin, moulage consisting of slight bruising on right abdomen, on a stretcher or hospital bed. Mannequin should be female.

Moulaged bruise can be made with removable makeup, or painted on to a Tegaderm (3M Healthcare, St Paul, MN) dressing and applied to the abdomen. It should have the appearance of a 3–5-day-old bruise, with a slight greenish tinge.

Props: To be displayed on plasma screen/computer screen or printed out on handouts in the scenario room when asked for/return from laboratory:

- Images (see online component for Intestinal Perforation, *Scenario 4.2.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - Chest X-ray that shows free air under the diaphragm.
 - Abdominal X-ray that shows free air under the diaphragm.
 - Focused assessment with sonography for trauma (FAST) showing no intraperitoneal free fluid.
 - Abdominal CT slice and accompanying radiology read showing intraperitoneal free air.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Hepatic function panel.
 - Lactate.
 - Lipase.
 - Urine pregnancy test.
 - Urine microscopy.
 - Urinalysis.

Available in the treatment room:

- Basic airway and code cart.
- Medications (labeled bags/syringes may be used in place of actual medicine syringes or bags):
 - IV fluids: normal saline (NS) or lactated Ringer's (LR).
 - Complement of ACLS medications.
 - Analgesics including morphine and fentanyl.
 - Antiemetics.
 - Antibiotics.
 - Induction and paralytic medications for rapid sequence intubation (RSI).

Distractor: The patient's extreme pain and lack of cooperation with the examination should act as a distractor. In addition, a patient's family member is optional and may

provide an additional level of distraction for advanced learners by constantly questioning the appropriateness of the patient's management.

Actors:

- Patient voice is female. Patient should be in significant pain and upset with any delays in her care. The patient should be very verbal and demanding and attempt to limit the learner's ability to perform an adequate examination.
- ED nurse can start IVs and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed.
- Patient family member (optional, see above).
- General surgeon can be available via "phone consultation."

Case narrative

Scenario background

A 32-year-old female presents to the ED with severe, sudden onset, right-sided abdominal pain. Pain began 2 h prior and is unremitting. It waxes and wanes in intensity and is associated with severe nausea and non-bloody/non-bilious emesis. If the learner specifically asks, the patient may state that she was struck in the abdomen during a dirt bike race one day ago but did not seek care at the time.

Background may be presented prior to case, or given as a triage sheet.

CC: Severe abdominal pain.

PMH: None.

Meds: None.

Allergies: None.

Family Hx: Unremarkable.

Social Hx: No smoking, occasional alcohol, no illicit drugs. Patient is a dirt bike racing competitor (provide this information only if occupation or history of trauma is asked).

Last menstrual period: 2 weeks ago.

Initial scenario conditions

Female moaning in severe pain.

VS: Temp. 38.8°C (101.8°F), HR 115, RR 23, BP 145/89, O₂ sat 97% RA.

Head, eyes, ears, nose, throat: Head is normocephalic and atraumatic, pupils equal, round, and reactive to light, extraocular movements intact, no lymphadenopathy, normal oropharynx, mucous membranes somewhat dry.

Heart: Tachycardia, no murmurs.

Lungs: Equal bilaterally, clear to auscultation.

Abdomen: When palpated, patient yells in pain, tells examiner to stop. This response is elicited whenever the examiner presses in any quadrant. Bruising to right abdomen. Bowel sounds hypoactive. Patient appears to be voluntarily guarding and will not relax abdomen. Distracting maneuvers are unsuccessful as patient becomes more angry and demanding with further attempts at examination.

Pelvic examination: Patient refuses.

Back: Moderate costovertebral tenderness on the right, but patient is relatively uncooperative with examination.

Skin: Bruising on right abdomen. If asked, patient says she got that during a dirt bike competition yesterday “but that’s not unusual for me to get hit with the handlebars.”

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners, e.g. as most mannequins are not realistic for palpation of the abdomen, abdominal examination findings may be verbally presented as the learners do palpation.

See the flow diagram in Figure 4.2 for further scenario changes described below.

Case narrative, continued

During the initial minutes, the learner should obtain the history and perform the physical examination. Initial medication, labs, and imaging orders should be placed. Any attempt to treat the patient with oral medications should result in the patient becoming very nauseated. After 5 min, the patient becomes angrier, more tachycardic, and more tachypneic.

During the next few minutes, labs and studies are returned. If learners appropriately diagnose intestinal perforation and begin treatment with IV fluids, antiemetics, analgesics, and antibiotics, the patient's condition will improve and her comfort level will increase.

If the learners misinterpret the images *or* do not attempt to treat the patient's pain and nausea with IV analgesics and antiemetics, the mannequin should vomit, the lung sounds will change to rales (right > left), and the vital signs will worsen, signifying aspiration.

At this point, the learners should roll the patient on her side and suction the airway in addition to providing some level of supplemental oxygen. If this is performed, the patient will improve. If suctioning or oxygen is not performed, the hypoxia will worsen to the point that the patient becomes somnolent, bradycardic, and ultimately arrests.

Once the patient has been stabilized, the learner should seek surgical consultation. A CT scan may be ordered during the time period either before or after consultation.

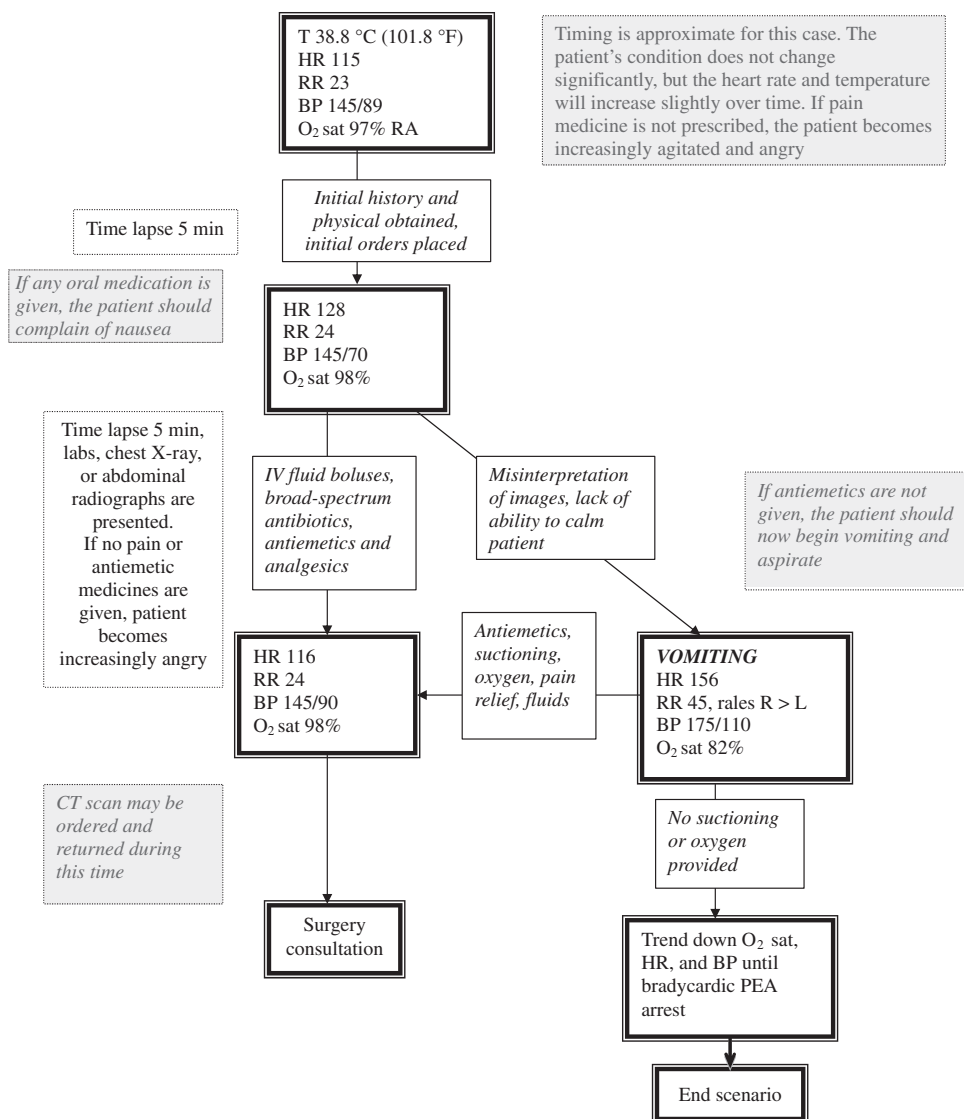


Figure 4.2 Scenario flow diagram: intestinal perforation.

Instructor notes

Pathophysiology

Perforation of hollow viscus can occur due to infection (appendicitis, diverticulitis), peptic ulcer disease, or trauma:

- Traumatic perforations are often acute, but can be delayed in presentation.
- The small bowel is the third most common site of perforation.
- Mechanisms underlying traumatic perforation:
 - Tangential tears along fixed points.
 - Increased intraluminal pressures.
 - Crushing against bony structures (i.e. vertebral bodies).
 - Necrosis from mesenteric avulsions.
 - Coagulation necrosis from blunt injury causing weakening of the wall.

Clinical features

- Severe abdominal pain, often acute onset.
- If the patient presents early, their abdominal examination may be soft with focal tenderness at the site of perforation.
- Once peritonitis has occurred, peritoneal signs (rigidity, rebound, guarding) and fever become more common.

Diagnosis

- Typically made by clinical suspicion plus radiographic imaging.
- Plain films can appear normal, especially soon after perforation.
- CT is more sensitive than plain films for small amounts of air.

Management

- Analgesics.
- Antiemetics.
- Nothing by mouth (NPO).
- Consider a nasogastric tube if there is vomiting or evidence of obstruction.
- Broad-spectrum antibiotics.
- IV fluids.
- Emergent surgical consultation.

Debriefing plan

Plan for ~30 min for discussion.

Potential questions for discussion

- What is your differential diagnosis for this patient's abdominal pain?
- If the patient had been elderly, would your differential diagnosis and initial approach have been any different?
- Describe your approach to the male patient, and then the female patient, with acute abdominal pain.

Selected reading

1. Espinoza R, Rodríguez A. Traumatic and non-traumatic perforation of hollow viscera. *Surg Clin North Am* 1997;**77**:1291–1304.
2. Hoff WS, Holevar M, Nagy KK, *et al.* Practice management guidelines for the evaluation of blunt abdominal trauma: the EAST Practice Management Guidelines Work Group. *J Trauma* 2002;**53**:602–615.

Mesenteric ischemia

Educational goals

Learning objectives

Primary:

1. Demonstrate a focused history and physical examination to assess for life-threatening causes of abdominal pain [*Medical Knowledge, Patient Care*].
2. Recognize the clinical signs and symptoms that suggest mesenteric ischemia as the etiology of abdominal pain [*Medical Knowledge*].
3. Demonstrate timely ancillary testing and therapy for a patient with mesenteric ischemia [*Patient Care*].

Secondary:

1. Demonstrate professionalism and communication skills during interactions with the patient, family, ED nurse, and surgical consultant [*Interpersonal and Communication Skills, Professionalism*].
2. Manage the patient's pain and nausea while completing assessment [*Patient Care*].
3. Demonstrate timely disposition and appropriate use of a consultant [*Systems-based Practice*].

Critical actions checklist

- ☐ Assess airway, breathing, circulation (ABCs) [*Patient Care*]
- ☐ Order an IV, supplementary oxygen, and initiate a cardiac monitor pulse oximetry, and blood pressure [*Patient Care*]
- ☐ Initiate fluid resuscitation to treat signs of hypoperfusion [*Patient Care, Medical Knowledge*]
- ☐ Complete a thorough examination of the abdomen and recognize the discordance between the patient's symptoms and the examination findings [*Medical Knowledge*]
- ☐ Obtain ancillary tests including portable radiographs of the chest and abdomen followed by CT angiography or mesenteric angiography if the patient is sufficiently stable to go to radiology [*Patient Care, Medical Knowledge*]
- ☐ Consult surgery for disposition (based on suspicion if the patient is too unstable to go to radiology or following CT scan if stable) [*Interpersonal and Communication Skills, Professionalism*]
- ☐ Frequently reassess vital signs, particularly following interventions [*Patient Care*]

Critical actions can be changed to address the educational needs of the learner.

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin on a stretcher, hemoccult-positive stool moulage.

Iodine mixed in chocolate pudding placed at the rectal opening to produce a positive reaction on hemoccult testing.

Mannequin can be male or female to match the operator's voice and should be moulaged to appear older (e.g. gray wig, bifocals).

Props: To be displayed on television screen/computer screen or printed out in simulation laboratory room when ordered by team leader:

- Images (see online component for Mesenteric Ischemia, *Scenario 4.3.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG showing atrial fibrillation with a ventricular response of 100.
 - Chest X-ray with mildly enlarged cardiac silhouette.
 - Abdominal X-ray that shows a faint air pattern in the portal veins.
 - Abdominal CT slice with accompanying radiology read, showing air in mesenteric veins.
 - Radiologist's preliminary reading of a CT angiogram.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Cardiac enzymes.
 - Coagulation profile.
 - Urinalysis.
 - Urine microscopy.
 - Hepatic function panel.
 - Lipase.
 - Lactate.

Available in the treatment room:

- Basic airway and code cart.
- Medications (actual containers filled with water replacing the medication, or labeled IV bags and syringes):
 - Heparin (both bolus and infusion concentrations).
 - Liter bags of IVF: normal saline (NS).
 - Parenteral analgesics and antiemetics.
 - Broad-spectrum antibiotics.
 - Vasopressors (e.g. dopamine, dobutamine, or a similar agent used at your institution).
- Hemoccult card and hemoccult developer.

Distractor: None.

Actors:

- Patient's voice can be male or female. Patient is alert, but stressed due to pain. During the course of the simulation, the patient will become hypotensive if not properly managed, at which point the speech may become slurred and lethargic.
- ED nurses can start IVs and administer medications/fluids. They will perform all requested tasks (within their scope of practice) to the best of their ability, but will not offer suggestions regarding findings or therapy. They will report changes in the patient's status (e.g. vital signs, level of consciousness).
- Radiologist is available via telephone to discuss study of choice and medical management with intra-arterial vasodilators if mesenteric angiography is performed.
- Surgical consultant is available in-person or via "phone consultation."

Case narrative

Scenario background

An 80-year-old male/female presents to the emergency department with a 12 h history of nausea and abdominal pain that started shortly after eating a large meal at a family reunion. The pain was initially a mild aching sensation that worsened over several hours. Over the last few hours, the patient tried antacids and extra-strength acetaminophen without relief.

Background is presented on the triage note.

CC: Gas pains.

PMH: Atrial fibrillation, congestive heart failure, hypertension, hyperlipidemia.

Meds: Atenolol, warfarin, atorvastatin, hydrochlorothiazide, enalapril.

Allergies: None.

Family Hx: Hypertension, coronary artery disease, diabetes mellitus.

Social Hx: No smoking, occasional alcohol, no illicit drugs.

Initial scenario conditions

Older man/women in moderate distress and moaning due to abdominal pain.

VS: Temp. 38.2 °C (100.8 °F), HR 102, RR 20, BP 102/70, O₂ sat 97% RA.

Eyes: Pupils are equal, reactive.

Heart: Tachycardia, irregularly irregular with no murmurs.

Lungs: Equal bilaterally, clear to auscultation.

Abdomen: Normal to inspection. Bowel sounds are diffusely decreased. No masses.

Minimal tenderness on palpation, without guarding or signs of peritoneal irritation.

Small amount of dark stool in the rectal vault.

Back: No costovertebral tenderness.

Skin: No bruising or rashes.

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners, e.g. the patient can respond that there is only minimal tenderness diffusely with palpation of the abdomen.

See the flow diagram in Figure 4.3 for further scenario changes described below.

Case narrative, continued

The patient will have no response to treatment with a single fluid bolus. During this period, the initial focused history and physical examination should be completed and the ECG radiographs and laboratory tests should be ordered. If an IV fluid bolus is not initiated, the patient's condition will start to deteriorate while the workup is being completed.

If a second fluid bolus is ordered, the patient's vital signs will remain stable enough to go to radiology for an abdominal CT. If a second bolus is not ordered, the patient will progress to decompensated shock, preventing transport to CT. If the learner addresses the deterioration with aggressive fluid management and vasopressors, the patient will stabilize sufficiently to complete the workup. If not, the patient will continue to deteriorate to pulseless electrical activity.

The learner should consult surgery or interventional radiology following results of imaging studies, or with clinical suspicion for mesenteric ischemia, and start broad-spectrum IV antibiotics if not done already.

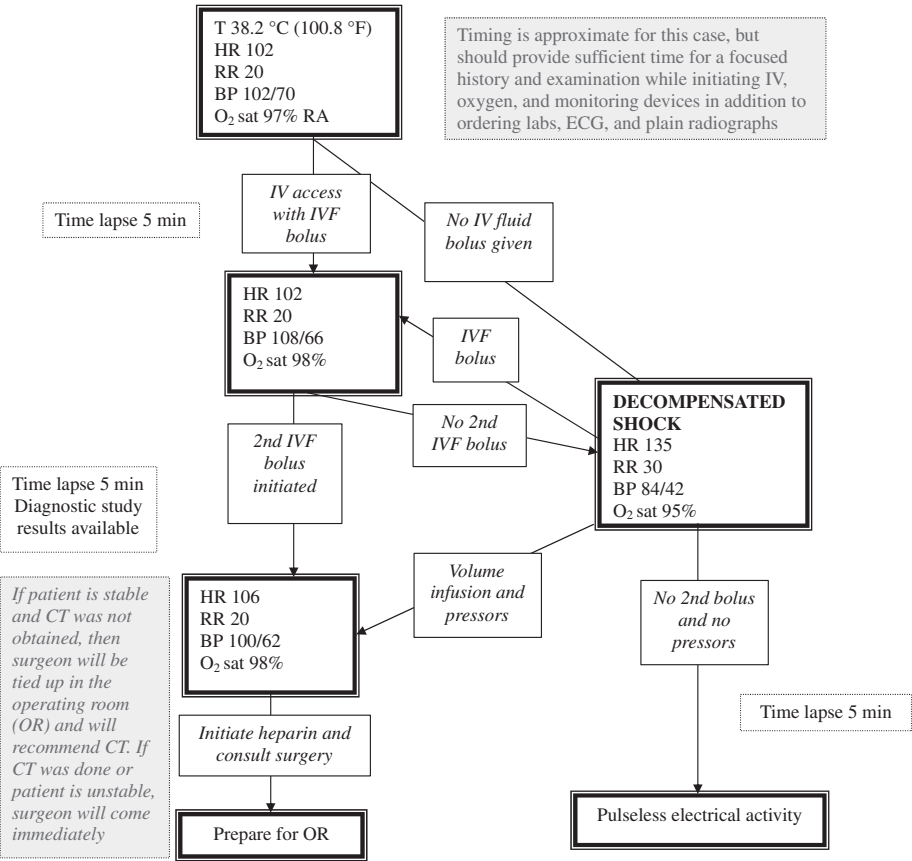


Figure 4.3 Scenario flow diagram: mesenteric ischemia.

Instructor notes

Pathophysiology

Acute mesenteric ischemia (AMI) has four potential etiologies:

- Arterial embolism:
 - 40–50% of cases with most emboli originating in the heart.
 - Associated with cardiomyopathy, valvular disease, ventricular aneurysms, and tachydysrhythmias (particularly atrial fibrillation).
 - Most frequently occurs in the superior mesenteric artery (SMA) distal to the first branch so that the duodenum and proximal jejunum are spared.
- Arterial thrombosis:
 - 25–30% of cases of AMI and associated with severe atherosclerotic disease.
 - Frequently has a more gradual onset than arterial embolus-induced ischemia.
 - Frequently occurs at the base of the SMA resulting in more extensive bowel involvement than arterial embolism.
- Non-occlusive mesenteric ischemia:
 - 20% of AMI cases.
 - Due to episodes of hypoperfusion due to hypotension and vasoconstriction.
 - Frequently occurs in critically ill patients and can thus go undetected for longer periods of time.
- Mesenteric venous thrombosis:
 - 10–15% of AMI cases.
 - Related to primary clotting disorders.

Clinical features

- Frequently presents as non-specific abdominal pain, but is characterized as pain out of proportion to the findings on physical examination.
- Signs of peritoneal irritation are a late finding indicating poor prognosis.
- The clinical presentation differs based on the underlying etiology:
 - Arterial embolism – Usually present with a sudden, dramatic onset of pain and one-third of patients have a history of previous embolic events.
 - Arterial thrombosis – More insidious onset than arterial embolism and 50–75% of patients have a history of prior episodes of postprandial pain and weight loss.
 - Non-occlusive mesenteric ischemia – Also more insidious in onset and occurs in patients with low flow states due to heart failure, hypovolemia, or treatment with vasoactive medications. May present as unresolved sepsis, or unexplained fever, abdominal distension, or GI bleeding.
 - Mesenteric venous thrombosis – Can present with sudden onset of pain, but frequently patients have vague intermittent abdominal pain over days or weeks with nausea, vomiting, and diarrhea.

Diagnosis

- Labs:
 - Anion gap acidosis and elevated lactate are common.

- Not sensitive or specific enough to be diagnostic.
- Must be suspected based on clinical features:
 - Age >60 years.
 - History of congestive heart failure, atrial fibrillation, recent myocardial infarction, or prior emboli.
 - Postprandial onset of pain.
 - Pain out of proportion to tenderness on examination.
- Radiographs:
 - Plain abdominal films: pneumatosis intestinalis, portal venous gas, thumb printing.
- CT scan:
 - Although CT can detect changes such as pneumatosis, it has poor sensitivity and specificity for AMI in general. However, it is the study of choice for mesenteric venous thrombosis.
 - Helps rule out other etiologies.
 - Thin slice CT angiography significantly improves detection.
- Mesenteric angiography:
 - High sensitivity, but frequently is not readily available and is very time consuming.
 - Can serve as both a therapeutic and diagnostic procedure with the infusion of a vasodilator such as papaverine.

Management

- Aggressive fluid management.
- Broad-spectrum antibiotics.
- Heparin bolus and infusion.
- Infusion of intravenous glucagon as a vasodilator following initial resuscitation and initiation of anticoagulation.
- Papaverine through angiography catheter for arterial embolus or non-occlusive AMI.
- Surgical management indicated for:
 - Mesenteric revascularization for AMI due to thrombosis.
 - AMI due to arterial occlusion.
 - Any cause with signs of peritonitis or bowel infarction (revascularization should be attempted if possible prior to bowel resection).
- Angiographic infusion of thrombolytics is a potential alternative for mesenteric venous thrombosis, but limited data are available.
- Percutaneous angioplasty with or without stenting.

Debriefing plan

Plan for ~30 min for discussion.

Potential questions for discussion

- What are the main life-threatening causes of abdominal pain for patient presenting to an ED?

- What clinical findings support a diagnosis of acute mesenteric ischemia in a patient with abdominal pain?
- What are the four etiologies of acute mesenteric ischemia?
- What tests are most useful for diagnosing acute mesenteric ischemia and how do they perform based on the etiology?
- What are the general management modalities used to treat acute mesenteric ischemia?
- How do the specific treatment modalities vary based on the etiology?

Selected reading

1. Berland T, Oldenburg WA. Acute mesenteric ischemia. *Curr Gastroenterol Rep* 2008;**10**:341–346.
2. Assar AN, Zarins CK. Acute mesenteric ischaemia: facts and perspectives. *Br J Hosp Med (Lond)* 2008;**69**:686–691.

Variceal bleeding

Educational goals

Learning objectives

Primary:

1. Demonstrate rapid assessment for immediate life threats in a patient presenting with hematemesis [*Patient Care*].
2. Demonstrate a focused history and physical examination to assess for life-threatening causes of hematemesis [*Medical Knowledge, Patient Care*].
3. Recognize the appropriate history and clinical signs that support portal hypertension and variceal bleeding as the etiology of hematemesis [*Medical Knowledge*].
4. Demonstrate timely ancillary testing and therapy for a patient with hematemesis [*Patient Care*].

Secondary:

1. Demonstrate professionalism and communication skills during interactions with the patient, family, ED nurse, and gastroenterology (GI) consultant [*Interpersonal and Communication Skills, Professionalism*].
2. Demonstrate concurrent management of the patient's hemorrhage and hemodynamic status while completing a focused assessment [*Patient Care*].
3. Demonstrate timely disposition and appropriate use of a consultant [*Systems-based Practice*].

Critical actions checklist

- ☐ Assess airway, breathing, circulation (ABC's) [*Patient Care*]
- ☐ Order an intravenous line and supplementary oxygen and initiate a monitor for cardiac rhythm, pulse oximetry, and blood pressure [*Patient Care*]
- ☐ Initiate fluid resuscitation to treat hypoperfusion and order a type and cross or type and screen [*Patient Care, Medical Knowledge*]
- ☐ Obtain ancillary tests including a complete blood count, coagulation studies, a complete metabolic panel, ECG, and a portable chest X-ray [*Patient Care, Medical Knowledge*]
- ☐ Initiate treatment with vasoactive agents (octreotide) and antibiotics (ceftriaxone or norfloxacin) [*Patient Care*]
- ☐ Address patient's anxiety over the substantial amount of bleeding and treat his nausea [*Patient Care, Professionalism*]
- ☐ Consult GI for evaluation and treatment of his suspected variceal hemorrhage [*Interpersonal and Communication Skills, Professionalism*]
- ☐ Frequently reassess vital signs particularly following interventions [*Patient Care*]

Critical actions can be changed to address the educational needs of the learner.

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin on a stretcher sitting up. Mannequin can be male or female. The mannequin has an emesis basin of “blood” on their lap. Moulage includes:

- Palmar erythema (light-red makeup on the palm of the hands).
- Caput medusae (thin, rubber tubing filled with dark-blue solution and tunneled under the skin surface of the replaceable abdominal tissue from a Trauma Man (Simulab Corporation, Seattle, WA). Optional: may substitute by showing the photograph in the online materials.
- Hemocult-positive stool moulage: iodine mixed in chocolate pudding placed at the rectal opening to produce a positive reaction on hemocult testing.

Props: To be displayed on plasma screen/computer screen or printed out in simulation laboratory when ordered by the team leader:

- Images (see online component for Variceal Bleeding, *Scenario 4.4.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG with sinus tachycardia.
 - Chest X-ray that shows normal cardiac silhouette.
 - Image of simulator mannequin with caput medusae.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Coagulation profile.
 - Lipase.
 - Hepatic function panel.
 - Blood alcohol level.

Available in the treatment room:

- Hemocult card and hemocult developer
- Bags labeled as O-negative blood
- Emesis basin filled with red fluid.
- Basic airway and code cart.
- Medications (actual containers filled with water replacing the medication, or labeled IV bags and syringes):
 - IVF: liter bags of normal saline (NS).
 - Proton pump inhibitor.
 - Parenteral antibiotics typically used for variceal bleed at your institution (eg. ceftriaxone).
 - Intravenous erythromycin.
 - Octreotide.

Distractor: None.

Actors:

- Patient can be male or female to match the voice of the mannequin operator. Patient is alert, but anxious due to bleeding. The patient is mildly hypotensive on

presentation and will worsen if not properly managed, at which point the speech may become slurred and lethargic.

- ED nurses can start IVs and administer medications/fluids. They will perform all requested tasks (within their scope of practice) to the best of their ability, but will not offer suggestions regarding findings or therapy. They will report changes in the patient's status (e.g. vital signs, level of consciousness).
- Gastroenterologist (GI) consultant is available in-person or via "phone consultation."

Case narrative

Scenario background

A 56-year-old male/female presenting to the emergency department with a history of vomiting bright-red blood three times in the previous 4 h. The patient denies any pain. On walking into the hospital from the parking lot he/she felt a little lightheaded without syncope. There was a large amount of blood with the last episode of emesis that occurred just after arriving in the emergency department.

Background is presented on the triage note.

CC: Vomiting blood.

PMH: Alcoholism, cirrhosis, hypertension.

Meds: Hydrochlorothiazide, enalapril.

Allergies: None.

Family Hx: Unknown (adopted).

Social Hx: Has smoked 1 pack of cigarettes per day for 30 years, a fifth of whiskey and two “40 ouncers” of beer a day, no illicit drugs.

Initial scenario conditions:

Patient is holding an emesis basin containing a moderate amount of bright-red blood and is alert and anxious about the amount of blood seen.

VS: Temp. 37°C (98.6°F), HR 120, RR 20, BP 94/62, O₂ sat 97% RA.

Eyes: Pupils equal, reactive with scleral icterus and pale conjunctiva.

Heart: Tachycardia, no murmurs.

Lungs: Equal bilaterally, clear to auscultation.

Abdomen: Caput medusae on inspection (see online image) with enlarged liver, but no tenderness to palpation. Active bowel sounds with normal pitch.

Back: No costovertebral tenderness.

Rectal: Maroon-colored hemoccult-positive stool.

Skin: No bruising or rashes.

Neurologic: Normal. Patient keeps expressing concern that he/she will bleed to death.

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners. For example, if you cannot moulage icteric sclera, then you can verbally report the sclera color when it is requested.

See the flow diagram in Figure 4.4 for further scenario changes described below.

Case narrative, continued

The patient will initially show some minor improvement if treated with a fluid bolus. During this period, the initial focused history and physical examination should be completed and the labs and imaging can be ordered. The patient is anxious and continues to ask about the bleeding and whether he is going to die. If the learner addresses the patient's concerns, the questions stop.

The patient's vital signs will remain stable long enough for the learner to evaluate the diagnostic studies. Additional actions include continued IV fluids, blood transfusion, and IV octreotide. If octreotide is not administered, the patient will begin to decompensate and will only improve if octreotide and blood are administered.

If an IV fluid bolus is not given initially, the patient's condition will start to deteriorate after the initial examination. The patient will complain of feeling lightheaded to prompt the learner. If the learner addresses the deterioration with aggressive fluid management/blood replacement, the patient will stabilize sufficiently to complete the workup. If not, the patient will continue to deteriorate to pulseless electrical activity over 10 min.

Once the patient is stabilized, the learner should consult the GI consultant, initiate treatment with a prophylactic IV antibiotic to cover Enterobacteriaceae and order IV erythromycin to enhance gastric emptying if endoscopy anticipated to occur within the next 30–90 minutes.

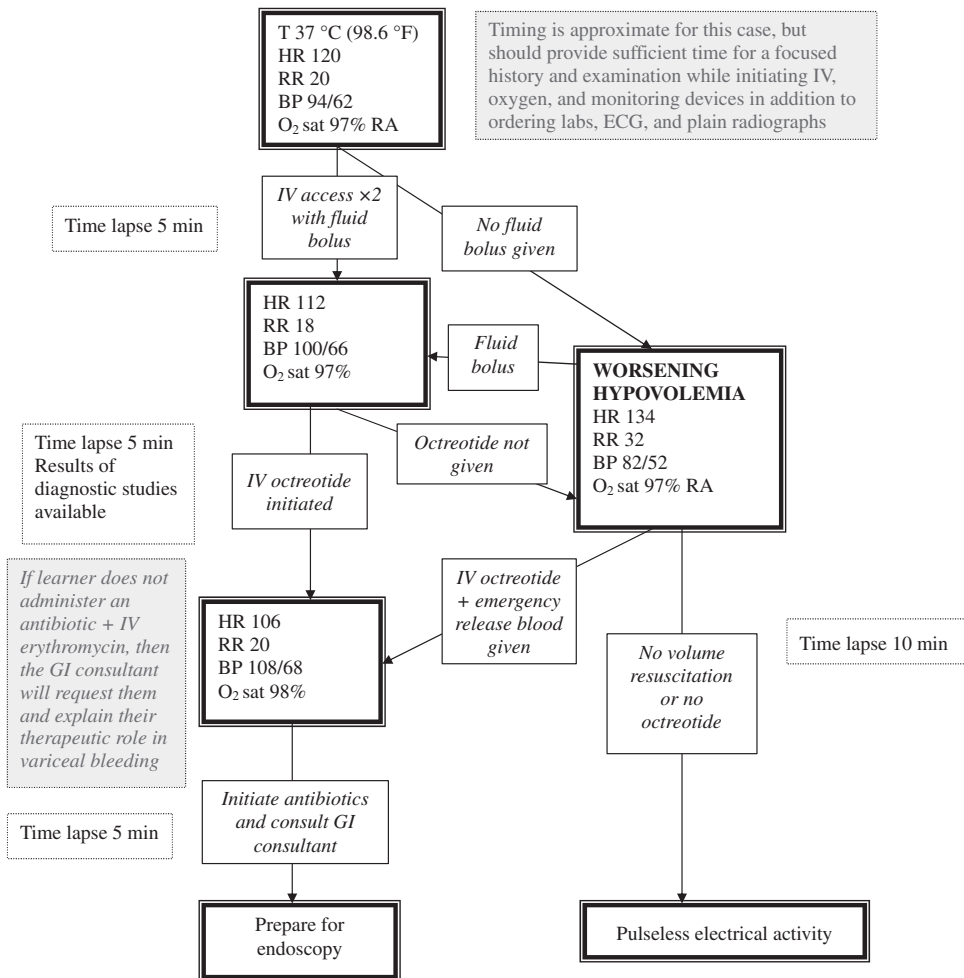


Figure 4.4 Scenario flow diagram: variceal bleeding.

Instructor notes

Pathophysiology

Upper gastrointestinal (UGI) bleeding can result from a number of conditions:

- Peptic ulcer disease:
 - 40–60% of cases.
 - Associated with pain.
- Mucosal erosive disease:
 - 20% of cases.
 - Associated with pain and includes lesions in the stomach, the esophagus, and the duodenum.
- Esophageal varices:
 - About 6% of cases overall, but in patients with cirrhosis ~70% of cases of UGI bleeding.
 - Complications include death from uncontrolled hemorrhage, re-bleeding, infection, and renal failure.
- Mallory–Weiss tears:
 - About 3.5% of cases.
 - Characterized by bleeding after an episode of gagging, vomiting, or coughing.

Diagnosis

- A history of cirrhosis or known varices increases the likelihood of variceal bleeding as the source of UGI bleeding.
- Signs of cirrhosis or portal hypertension on examination increase the likelihood of varices as the source of UGI bleeding.
- Placement of a nasogastric tube has limited diagnostic utility if there is clear evidence of hematemesis and early endoscopy is anticipated. In selected cases, it can help confirm active bleeding.³
- Endoscopic examination is needed to identify the definite source of bleeding and can serve as both a therapeutic and a diagnostic procedure.

Management

- Aggressive fluid management with isotonic crystalloid.
- Blood replacement:
 - For non-responders or transient responders to 2 L of IV fluids.
- Vasoactive medications (IV):
 - Octreotide, somatostatin, or terlipressin.
- Antibiotics:
 - Cover Enterobacteriaceae, which produce spontaneous bacterial peritonitis, urinary tract infections, or sepsis in about one-third of cirrhotic patients following a variceal bleed.
- IV erythromycin:
 - Motilin receptor agonist to enhance gastric emptying and improve the diagnostic capability with endoscopy.
 - Typically administered 30–90 minutes prior to endoscopy

- Endoscopy:
 - For sclerotherapy or ligation.
- Transjugular intrahepatic portosystemic shunt (TIPS):
 - Manage uncontrolled variceal bleeding or management with a surgical portosystemic shunt.
- Activated factor VII:
 - May be effective in patients with refractory bleeding.

Debriefing plan

Plan for ~15 min for discussion.

Potential questions for discussion

- What are the main life-threatening causes of gastrointestinal bleeding in a patient presenting to an ED?
- What factors help you differentiate upper GI bleeding from lower GI bleeding?
- What elements of history and physical examination increase the likelihood that hematemesis is due to bleeding from esophageal varices?
- What diagnostic tests are most useful for diagnosing the source of an upper GI bleed?
- What treatment options are available for refractory variceal bleeding?
- What is the purpose of antibiotic therapy in the management of a patient with bleeding from esophageal varices?

Selected reading

1. Kovacs TO. Management of upper gastrointestinal bleeding. *Curr Gastroenterol Rep* 2008;**10**:535–542.
2. McGuirk TD, Coyle WJ. Upper gastrointestinal tract bleeding. *Emerg Med Clin North Am* 1996;**14**:523–545.
3. Witting, M.D. “You wanna do what?!” Modern indications for nasogastric intubation. *Emerg Med* 2007;**33**(1):61–64.
4. Thabut D, Bernard-Chabert B. Management of acute bleeding from portal hypertension. *Best Pract Res Clin Gastroenterol* 2007;**21**:19–29.

CHAPTER 5 **Renal/electrolyte emergencies**

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Hypomagnesemia

Educational goals

Learning objectives

Primary:

1. Recognize clinical signs and symptoms of hypomagnesemia [*Medical Knowledge*].
2. Recognize risk factors for hypomagnesemia. [*Medical Knowledge*].
3. Demonstrate appropriate treatment for hypomagnesemia [*Medical Knowledge, Patient Care*].

Secondary:

1. Demonstrate good communication with team members during resuscitation of the acute patient [*Interpersonal and Communication Skills, Professionalism*].
2. Demonstrate good communication with paramedics [*Interpersonal and Communication Skills, Professionalism*].

Critical actions checklist

- ☐ Assess airway, breathing, and circulation [*Patient Care*]
- ☐ Observe cervical spine precautions in a patient who cannot be clinically cleared [*Patient Care*]
- ☐ Obtain fingerstick glucose test [*Patient Care*]
- ☐ Appropriately manage a seizure with IV benzodiazepines [*Medical Knowledge, Patient Care*]
- ☐ Recognize polymorphic ventricular tachycardia and treat following current ACLS protocols [*Medical Knowledge, Patient Care*]
- ☐ Option for junior/senior learners: Perform intubation for respiratory failure [*Patient Care, Medical Knowledge*]

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Adult simulator mannequin, mouldaged to show posterior scalp injury covered by bloody bandage. Mannequin dressed in disheveled street clothing, smelling of alcohol (Immediately before the simulation, alcohol may be used to dampen the front of the clothing to create the correct smell). Patient should also have vomit on the front of the shirt. Vomit can be mouldaged using water mixed with oatmeal with food coloring added as needed.

Props: To be displayed on plasma screen/computer screen or printed out on handouts in scenario room when asked for/return from laboratory:

- Labs (see online component for Hypomagnesemia, *Scenario 5.1.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - Complete blood count.
 - Complete metabolic panel + magnesium level.
 - Coagulation profile.
 - Cardiac enzymes.
 - Urinalysis.
 - Urine toxicology.
 - Serum toxicology.

Available in the treatment room:

- Basic airway and code cart with defibrillator.
- Suction set-up.
- Hard cervical collar.
- Medications (actual containers filled with water replacing the medication, or labeled IV bags and syringes):
 - IVF: liter bags of normal saline (NS) and lactated Ringer's (LR).
 - IV benzodiazepine (midazolam, lorazepam, or diazepam).
 - Rapid sequence intubation medications (sedative and paralytic typically used at your institution).
 - Magnesium sulfate 2 g in labeled IV bag.

Distractors: None.

Actors:

- Patient voice is male. He does not speak, but does mumble in response to painful stimuli.
- Paramedic(s) provide background information for the case, and because they are familiar with the patient, they are able to provide patient history (only if asked specifically by learners).
- ED nurse can start IVs and administer medications/IVF. The nurse does have some medical knowledge base and may cue learners if needed
- ICU physician consultant can be available via "phone consultation."
- Option: neurology consultant and/or cardiology consultant can be available via "phone consultation."

Case narrative

Scenario background

A middle-aged male collapsed one block away from the hospital. The patient was noted by paramedics to be a “drunk” (“This guy is always being taken to one hospital or another. He’s a nasty drunk, who usually wakes up agitated and starts swearing and swinging”).

CC: Witnessed collapse.

PMH: Diabetes, heavy chronic alcohol use, hypertension.

Meds: Metformin, hydrochlorothiazide.

Allergies: None.

Family Hx: Hypertension, diabetes.

Social Hx: No tobacco, 2 pints of vodka daily, snorts heroin and cocaine.

Initial scenario conditions

Middle-aged male lying on stretcher.

VS: Temp. 36 °C (96.83°F), HR 92, RR 8, BP 157/89, O₂ sat 93% on RA.

Fingerstick glucose test: HIGH.

Head: Superficial abrasion to the posterior occiput.

Pupils: Dilated at 5 mm, equal and reactive. No scleral icterus.

Mouth: Gag reflex intact.

Neck: No step-off, no response to palpation.

Heart: Regular rate, rhythm. 2+ pulses throughout.

Lungs: Equal with diffuse rhonchi.

Abdomen: Normal bowel sounds, non-tender, non-distended.

Neurologic: Localizes to deep sternal rub, opens eyes and mumbles incoherently.

There is no clonus and reflexes are 4+ throughout.

Skin: Unremarkable except for scalp wound.

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners (e.g. the neurologic examination can be provided verbally when it is requested or tested by the learners).

See the flow diagram in Figure 5.1 for further scenario changes as described below.

Case narrative, continued

Learners should initially recognize the potential for a traumatic cervical injury, place the patient in a hard cervical collar, and follow spine precautions throughout. The learners should order IV access and place the patient on the cardiac monitor and pulse oximetry. If a fingerstick glucose test is ordered, the reading is HIGH (>500 mg/dL). Laboratory and imaging studies may be ordered at this time; however, there will be no time for imaging to be completed prior to the end of the case.

After 5 min or completion of above tasks, the patient begins to seize. If learners provide a dose of an IV benzodiazepine, the seizure will stop. If learners do not administer a benzodiazepine for the seizure, the nurse may cue them to do so.

After the seizure, the patient is apneic and requires intubation for airway support. The patient is difficult to bag and if not intubated will become progressively more hypoxic until PEA arrest results.

Apnea requiring intubation may be omitted for student learners. Instead, the patient can progress immediately from seizure to polymorphic VT.

Once intubated, the patient develops pulseless, polymorphic VT, which should be displayed on the monitor. This rhythm will be converted to sinus tachycardia after the patient has been given at least 2 g of magnesium. Laboratory results may return after the patient arrests to cue the learners to administer magnesium. The polymorphic VT will transiently convert with defibrillation but will rapidly degrade again into polymorphic VT until IV magnesium is administered.

The case will end after successful conversion of polymorphic VT and consultation with the ICU for admission. Standard post-arrest care for your institution should be initiated. Optionally, consultation with cardiology and/or neurology may be obtained prior to the patient's admission.

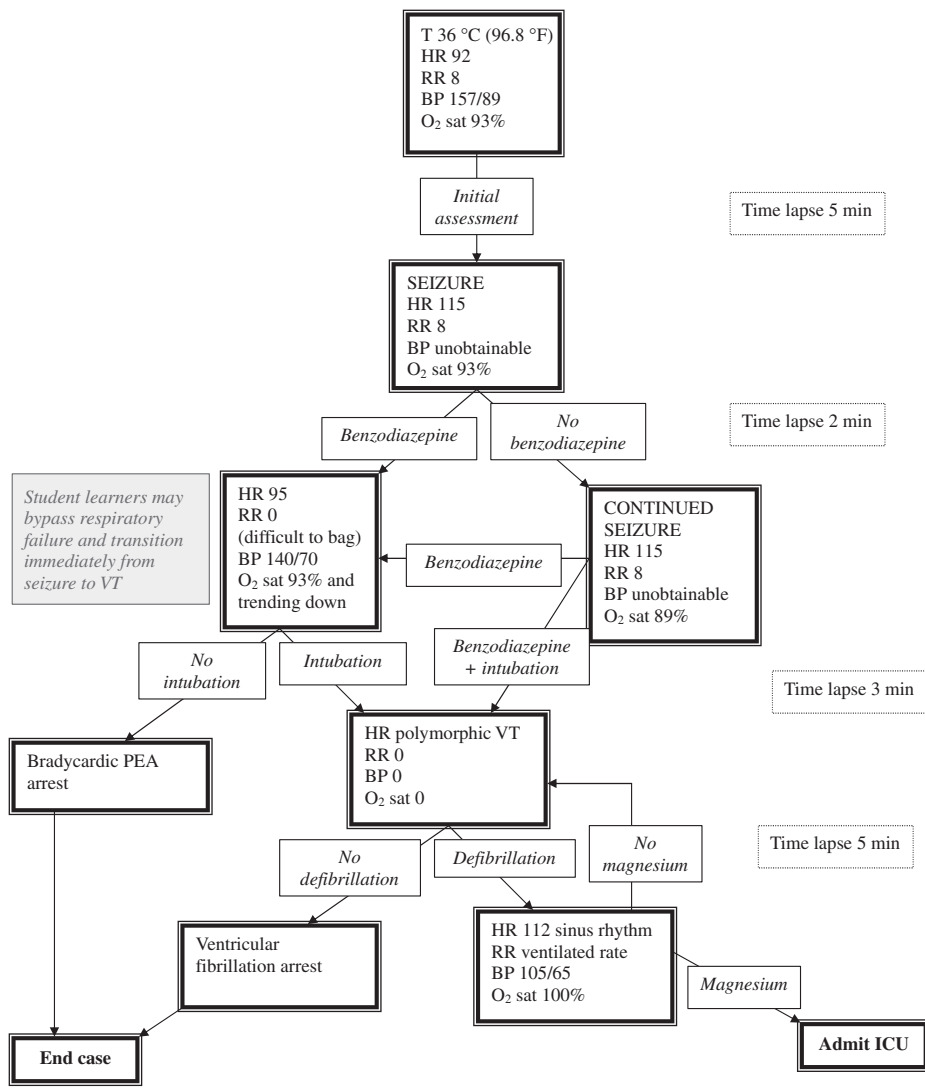


Figure 5.1 Scenario flow diagram: hypomagnesemia.

Instructor notes

Pathophysiology

- Magnesium is a vital electrolyte for cells.
- Magnesium loss can occur through multiple systems:
 - Renal excretion of magnesium:
 - Excretion increased during hyperosmolar states such as hyperglycemia or alcohol use.
 - Less reabsorption in chronic metabolic acidosis or phosphate depletion.
 - Wasting from medications such as thiazides and loop diuretics.
 - GI loss of magnesium:
 - Malabsorption, from diarrhea, or decreased reabsorption of GI secretions.
 - Decreased levels of magnesium present, from chronic malnutrition or magnesium binding in the intestine from dietary phosphate.

Clinical features

- Symptoms often not present until levels <1.8 meq/L:
 - Variability in onset of symptoms and level of serum magnesium.
 - Often associated with hypophosphatemia, hypocalcemia, and/or hypokalemia.
- Cardiac dysrhythmias.
- Neuronal irritability:
 - CNS: seizures, altered mental status, ataxia.
 - Peripheral: hyperreflexia, cramping.
- Gastrointestinal:
 - Esophageal dysmotility, causing dysarthria and dysphagia.

Diagnosis

- Magnesium levels <1.8 meq/L.

Treatment

- Magnesium repletion:
 - If asymptomatic or mild symptoms:
 - Daily oral replacement.
 - Moderate symptoms (e.g. cramping, hyper-reflexia):
 - IV magnesium 1–4 g over 1–2 h:
 - Hypotension can develop, particularly in faster infusions or larger doses.
 - Total body equilibration is slow; levels drawn after infusion may not reflect true total body magnesium.
 - Abrupt increase will change renal absorption, and up to 50% of infusion may be excreted.
 - Severe symptoms (e.g. torsades de pointes):
 - IV magnesium 1–2 g over 30–60 s, may be repeated in 5–15 min.
 - Continuous infusion of magnesium at 3–10 mg/min.

Debriefing plan

Plan ~30 min for discussion.

Potential questions for discussion

- What are the symptoms of hypomagnesemia?
- What are predisposing conditions that place someone at risk for developing symptomatic hypomagnesemia?
- What ECG findings suggest hypomagnesemia?
- What are other laboratory abnormalities associated with low magnesium?
- What is the correct way to replete magnesium depletion?

Selected reading

1. Fulop T. Hypomagnesemia in emergency medicine. <http://emedicine.medscape.com/article/767546-overview>. Updated: November 3, 2011 (last accessed May 15, 2012).
2. Lodner M, *et al.* Fluid and electrolyte problems. In: Tintinalli JE, Kelen GD, Stapczynski JS, eds. *Emergency Medicine*. New York: McGraw-Hill, 2000.
3. Sinert R. Renal and genitourinary disorders. In: Tintinalli JE, Kelen GD, Stapczynski JS, eds. *Emergency Medicine*. New York: McGraw-Hill, 2000.

Hypercalcemia

Educational Goals

Learning Objectives

Primary:

1. Recognize and treat hypovolemia. [*Medical Knowledge, Patient Care*].
2. Recognize ECG findings and laboratory abnormalities that are consistent with hypercalcemia [*Medical Knowledge*].
3. Generate differential diagnoses for causes of hypercalcemia [*Medical Knowledge*].
4. Demonstrate appropriate treatment for hypercalcemia [*Medical Knowledge, Patient Care*].

Secondary:

1. Demonstrate good communication with ED nurse [*Interpersonal and Communication Skills, Professionalism*].
2. Demonstrate good communication with consultants [*Interpersonal and Communication Skills, Professionalism*].

Critical actions checklist

- ☐ Assess airway, breathing, and circulation [*Patient Care*]
- ☐ Order ECG and appropriately identify findings consistent with hypercalcemia [*Medical Knowledge*]
- ☐ Initiate IV fluid bolus for hypotension [*Medical Knowledge, Patient Care*]
- ☐ Treat hypercalcemia appropriately [*Medical Knowledge, Patient Care*]
- ☐ Call and communicate admission to admitting physician [*Interpersonal and Communication Skills, Professionalism*]

Simulation set-up

Environment: Emergency department treatment area.

Mannequin: Simulator mannequin already on stretcher in gown, male set-up.

Props: To be displayed on plasma screen/computer screen or printed out on handouts in scenario room when asked for/return from laboratory:

- Images (see online component for Hypercalcemia, *Scenario 5.2.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG with bradycardia and complete heart block.
 - Normal chest X-ray.
 - Radiology report of CT abdomen/pelvis showing a 2 mm stone in the left ureteral vesicular junction.
- Labs (see online component as above):
 - Complete blood count.
 - Complete metabolic panel.
 - Ionized calcium.
 - Cardiac enzymes.
 - Urinalysis.

If learners order studies not listed above (e.g. parathyroid hormone or thyroid-stimulating hormone), you can verbally report these labs as pending.

Available in the treatment room:

- Basic airway and code cart.
- Medications (actual containers filled with water replacing the medication, or labeled IV bags and syringes):
 - IV furosemide.
 - IV Zoledronic acid (zoledronate) (or other similar bisphosphonate used at your institution).
 - Calcitonin.
 - 0.9% normal saline in labeled liter bags.

Distractor: None.

Actors:

- Patient's voice is male. The patient is a reluctant historian and must be directly asked questions to receive specific answers.
- Patient's wife is also able to provide some history, but is unaware of the extent of her husband's symptoms.
- ED nurse can start IVs and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed. This is especially helpful when the learner deviates inappropriately from the scenario.
- Admitting physician is available by "phone consultation."
- Nephrology/endocrinology consultant may be available by "phone consultation" if desired.

Case narrative

Scenario background

A 68-year-old male complains of severe left flank pain which radiates to his groin and is associated with nausea, vomiting, and constipation for the past 10 days. His appetite has been decreasing over the last several weeks, and he has felt unusually tired. His back pain is similar to other episodes of kidney stones he has had. He cannot recall his last bowel movement, but knows it has been at least a couple of days. He has had non-bloody and non-bilious vomiting since yesterday. He is not hungry but he feels constantly thirsty and is urinating frequently. He denies any fever, chills, or burning with urination.

CC: Flank pain.

PMH: Diabetes, hypertension, nephrolithiasis, gastroesophageal reflux.

Meds: Metformin, amlodipine, ranitidine, calcium carbonate as needed.

Allergies: Penicillin.

Family Hx: Diabetes and hypertension.

Social Hx: One pack of cigarettes per day for 52 years, alcohol occasionally, no drugs, retired accountant, lives with wife.

Initial scenario conditions

Patient is alert sitting up on the stretcher.

VS: Temp. 36.8°C (98.2°F), HR 50, RR 18, BP 95/60, O₂ sat 92% on RA.

Fingerstick glucose test: 89 (provided only if requested).

Eyes: Pupils equal, reactive to light.

Mouth: Dry mucus membranes.

Heart: Bradycardic regular rhythm, no murmurs.

Lungs: Clear bilaterally.

Abdomen: Decreased bowel sounds, distended and minimally tender throughout.

Back: Patient reports spinous process tenderness in lumbar region.

Extremities: 2+ pulses, no edema.

Physical examination findings not available on your mannequin, such as tongue fasciculations and replace with back tenderness, can be reported verbally if asked for by learners.

See flow diagram in Figure 5.2 for further scenario changes described below.

Case narrative, continued

Learners should request an IV and IV fluids. If atropine or pacing is requested, this may be done but will not change the blood pressure. The blood pressure will respond only to infusion of IV fluids.

Labs and imaging studies (if ordered) should return after completion of history/physical and administration of IV fluids. Learners should identify hypercalcemia based on labs and initiate appropriate therapy with further IV fluids, bisphosphonates, and calcitonin. If hypercalcemia is not recognized and/or not treated, the learners should be cued by the admitting physician to make a diagnosis and initiate appropriate treatment.

Consultation with nephrology and or endocrinology may occur but is not critical. The case should end after the learner has discussed the case with the admitting physician.

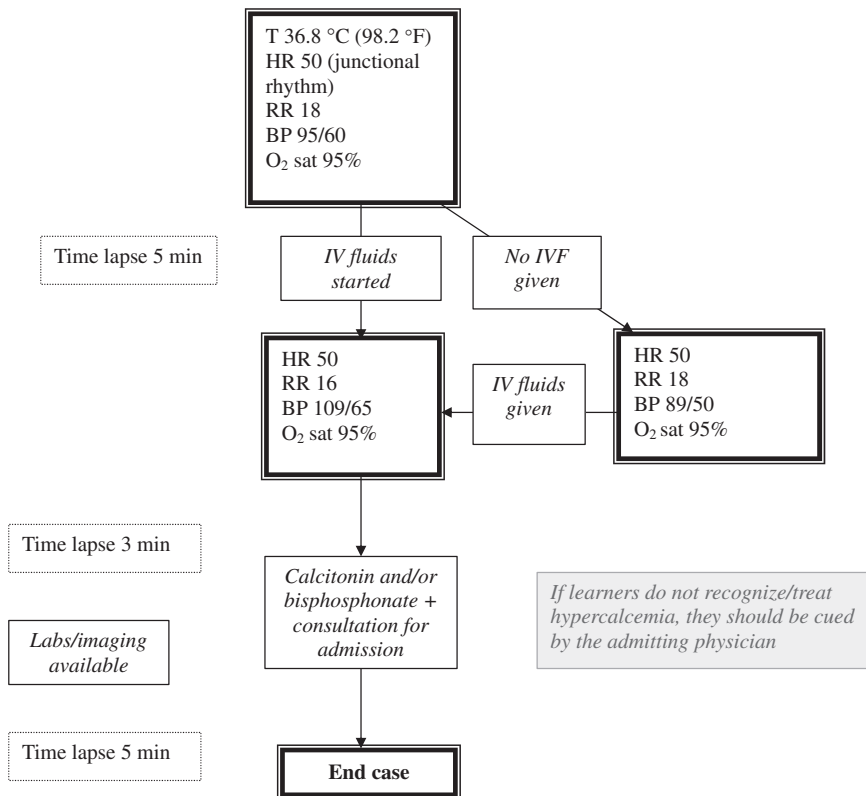


Figure 5.2 Scenario flow diagram: hypercalcemia.

Instructor notes

Pathophysiology

- 90% of cases are secondary to malignancy or primary hyperparathyroidism:
 - Malignancy:
 - Derangement of osteoclast/osteoblast activity.
 - Parathyroid hormone-like protein release.
 - Primary hyperparathyroidism:
 - Induces calcitriol synthesis → increases absorption of calcium from the small intestine.
 - Limits excretion of calcium in the distal renal tubule.
- Other causes include kidney disease, medications, immobilization, endocrine disorders, vitamin D excess, and dietary calcium excess.

Clinical features

- Symptoms usually develop with calcium levels >12 mg/dL.
- Gastrointestinal symptoms:
 - Nausea, anorexia, vomiting, constipation.
- Renal symptoms:
 - Pain from renal calculi, polyuria, and polydipsia.
- Neurologic symptoms:
 - Lethargy, weakness, confusion.
- Bone pain.
- Concomitant electrolyte abnormalities:
 - Hypokalemia.
 - Hyponatremia.
- ECG changes:
 - Shortened QT.
 - Prolonged PR.
 - Diffuse flattening of T waves.
 - Widened QRS.
 - Variable degrees of heart block.

Diagnosis

- Corrected serum calcium levels or ionized calcium levels:
 - Mild = serum Ca <12 mg/dL; ionized Ca 5.6–8 mg/dL.
 - Moderate = serum Ca 12–14 mg/dL; ionized Ca 5.6–8 mg/dL.
 - Severe = serum Ca >14 mg/dL; ionized Ca 10–12 mg/dL.

Treatment

- Volume repletion.
- Loop diuretics:
 - Can be used concomitantly with IVF once volume is restored.
 - Blocks sodium and calcium reabsorption in kidney.

- Bisphosphonates:
 - Interfere with osteoclast activity.
 - Onset of action is 24–72 h.
- Calcitonin:
 - Increases calcium excretion and inhibits bone resorption.
 - Onset of action is 4–6 h.
- Dialysis.

Debriefing Plan

Plan ~30 min for discussion.

Potential questions for discussion

- What are the symptoms of hypercalcemia?
- Are there specific laboratory findings that you should evaluate when working up hypercalcemia?
- What are the underlying conditions that must be evaluated in a patient presenting with hypercalcemia?
- What medications may cause or exacerbate hypercalcemia?

Selected reading

1. Hemphill, RR. Hypercalcemia in emergency medicine. <http://emedicine.medscape.com/article/766373-overview>. Updated: March 9, 2011 (last accessed May 15, 2012).
2. Thomas CP. Syndrome of inappropriate antidiuretic hormone secretion. <http://emedicine.medscape.com/article/768380-overview>. Updated: January 12, 2012 (last accessed May 15, 2012).
3. Lodner M., *et al.* Fluid and electrolyte problems. In: Tintinalli JE, Kelen GD, Stapczynski JS, eds. *Emergency Medicine*. New York: McGraw-Hill, 2000.
4. Sinert R. Renal and genitourinary disorders. In: Tintinalli JE, Kelen GD, Stapczynski JS, eds. *Emergency Medicine*. New York: McGraw-Hill, 2000.
5. Sverha J, Borenstein M. Emergency complications of malignancy. In: Tintinalli JE, Kelen GD, Stapczynski JS, eds. *Emergency Medicine*. New York: McGraw-Hill, 2000.

Renal failure

Educational goals

Learning objectives

Primary:

1. Recognize the clinical signs of renal failure. [*Medical Knowledge*].
2. Identify and properly manage cardiac tamponade [*Medical Knowledge, Patient Care*].
3. Initiate appropriate treatment for hyperkalemia [*Medical Knowledge, Patient Care*].
4. Identify and properly manage ventricular fibrillation (VF) [*Medical Knowledge, Patient Care*].

Secondary:

1. Demonstrate good communication with team members during the care of the acute patient [*Interpersonal and Communication Skills, Professionalism*].
2. Demonstrate good communications skills with consultants [*Interpersonal and Communication Skills, Professionalism*].

Critical actions checklist

- ☐ Inquires about past medical history and medications [*Patient Care*]
- ☐ Assess airway, breathing, and circulation [*Patient Care*]
- ☐ Appropriately manages VF arrest [*Medical Knowledge, Patient Care*]
- ☐ Recognizes and treats hyperkalemia with calcium, insulin, and glucose (\pm sodium bicarbonate, albuterol) [*Medical Knowledge, Patient Care*]
- ☐ Utilizes ultrasound to assess for pericardial effusion [*Patient Care*]
- ☐ Performs pericardiocentesis for tamponade physiology [*Medical Knowledge, Patient Care*]
- ☐ Consults nephrology for initiation of dialysis [*Patient Care, Systems-based Practice*]

Simulation set-up

Environment: Emergency department treatment area.

Mannequin: Simulator mannequin, adult male, intubated with 8.0 endotracheal (ET) tube, lying on EMS stretcher. A torso trainer may also be available for learners to perform pericardiocentesis.

Props: To be displayed on plasma screen/computer screen or printed out on handouts in scenario room when asked for/return from laboratory:

- Images (see online component for Renal Failure, *Scenario 5.3.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - Ultrasound of the heart showing effusion and tamponade.
 - Radiology report of a post-intubation chest X-ray showing cardiomegaly with an endotracheal tube in adequate position.
 - ECG with findings consistent with hyperkalemia (loss of P wave, wide QRS, peaked T waves).
- Labs (see online component as above):
 - Complete blood count.
 - Complete metabolic panel.
 - Coagulation panel.
 - Cardiac enzymes.

Available in the treatment room:

- Basic airway and code cart with defibrillator.
- Medications (actual containers filled with water replacing the medication, or labeled IV bags and syringes):
 - IV furosemide.
 - Ampules of calcium chloride or calcium gluconate.
 - Ampules of 50% dextrose (D50).
 - Ampules of sodium bicarbonate.
 - IV regular insulin.
 - Ampules of 1:10 000 epinephrine.
 - 0.9% normal saline in labeled liter bags.
- Pericardiocentesis procedure tray or an 18 gauge spinal needle and 20 mL syringe.

Distractor: None.

Actors

- Patient's sibling is able to provide some history.

The information voluntarily provided by the sibling can change based on the level of learners: for advanced learners, the past medical history and history of missed dialysis sessions should be provided only after specific inquiry. Additionally, the medication list may be "unknown" for these participants.

- Paramedics are present and are actively performing chest compressions and bagging. They can provide information about the scene and pre-hospital care.
- ED nurse can start IVs and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed.
- Consulting and admitting physicians are available by telephone.

Case narrative

Scenario background

A 53-year-old male brought in by EMS in VF arrest. His sibling reports that they spoke earlier in the day and he had made some inappropriate statements and seemed to be confused and breathing hard. The sibling thinks the patient missed the last dialysis session because of transportation problems. EMS was called by the patient's sibling when the patient "passed out" getting into the car on the way to dialysis.

CC: Cardiac arrest.

PMH: End-stage renal disease, on hemodialysis; hypertension, diabetes, hyperlipidemia, coronary artery disease, asthma.

Meds: Lisinopril, insulin, simvastatin, aspirin, metoprolol, albuterol, hydrocortisone cream.

Allergies: None.

Family Hx: Hypertension, diabetes, coronary artery disease.

Social Hx: Half a pack of cigarettes per day, occasional alcohol, no drugs.

Initial scenario conditions

Patient is intubated lying on a stretcher with active compression/bagging being performed.

VS: Temp. 37.2 °C (99 °F), HR VF on monitor, RR bagged rate, BP 0, O₂ sat not registering. Fingerstick glucose test (if asked) 213.

Eyes: Pale conjunctiva, pupils equal, no reaction to light.

Mouth: Dry mucus membranes, ET tube in place to 24 cm at the lip.

Neck: Jugular venous distension (JVD) to angle of mandible.

Lungs: Rales bilaterally with bagging.

Heart: No heart sounds appreciated.

Abdomen: Distended.

Neurologic: Unresponsive, flaccid.

Extremities: Pitting edema to knees, no peripheral pulses.

Physical examination findings not available on your mannequin, such as JVD or peripheral edema, can be reported verbally if asked for by learners.

See the flow diagram in Figure 5.3 for further scenario changes described below.

Case narrative, continued

The patient presents in ventricular fibrillation secondary to hyperkalemia. The rhythm will only convert with administration of calcium. If calcium is not administered prior to defibrillation, the rhythm will convert to pulseless electrical activity (PEA). If calcium is administered, this will convert the rhythm to a sinus tachycardia.

Following rhythm conversion, the patient will remain hypotensive secondary to a pericardial effusion. If fluids are given, there is brief improvement in blood pressure. If vasopressors are given, these will not change the blood pressure significantly. The hypotension will not improve until the pericardial effusion is diagnosed and treated with pericardiocentesis. Without pericardiocentesis, the patient's blood pressure will continue to drop until PEA arrest develops.

Depending on your learning objectives, performance of pericardiocentesis can be evaluated using a torso trainer or the learners can verbally recite the steps of the procedure as they would perform them.

Any labs/imaging that were initially ordered may return at this time. Learners should initiate further management of hyperkalemia and consult nephrology for emergent dialysis.

Should learners fail to manage hyperkalemia appropriately, the patient will have another VF arrest. The case should end after learners consult with the intensive care unit for admission of the patient.

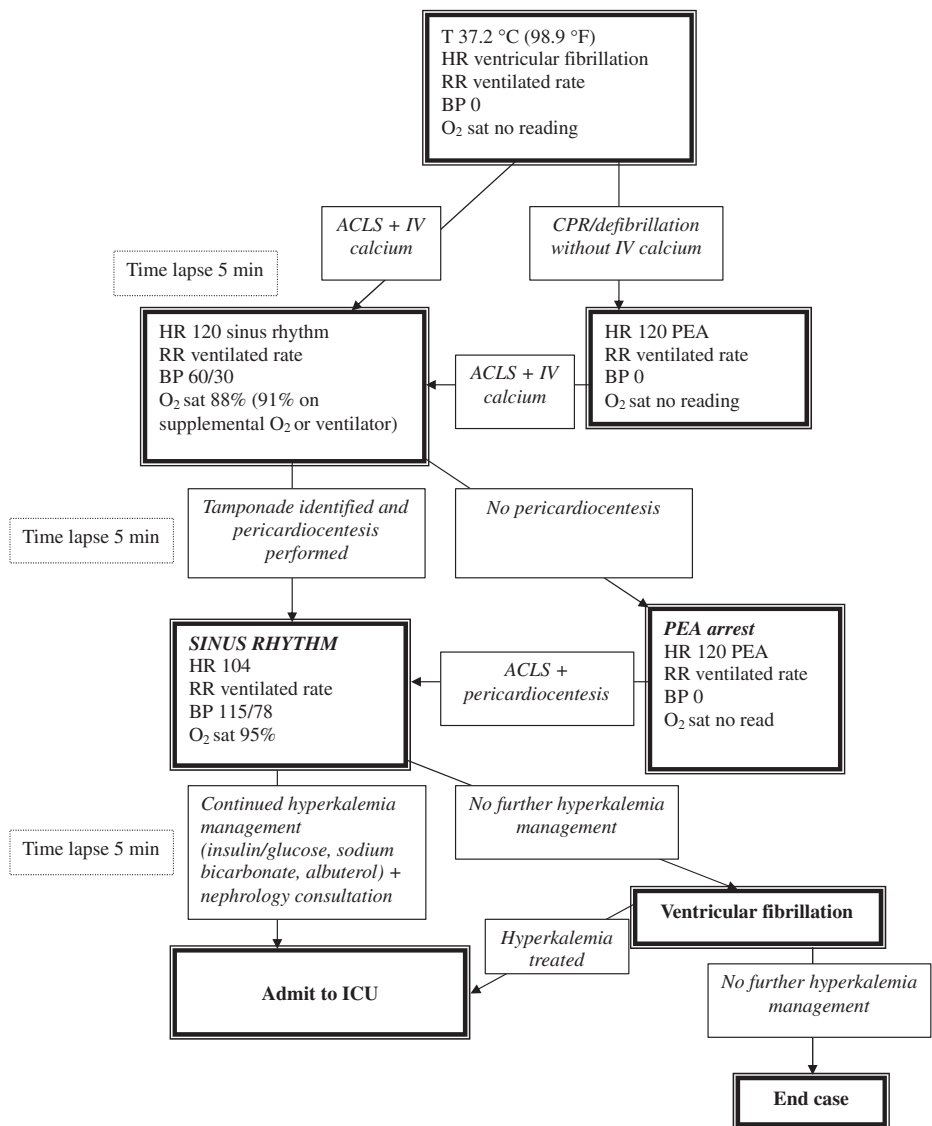


Figure 5.3 Scenario flow diagram: renal failure.

Instructor notes**Pathophysiology**

- Renal failure causes decreased excretion of toxins and metabolites, decreased hormone production, and coagulation dysfunction:
 - Metabolic abnormalities:
 - Hyperkalemia.
 - Acidemia.
 - Anemia.
 - Coagulopathy.
 - Other systemic effects:
 - Vitamin D, parathyroid, and calcium abnormalities
 - Endocrine effects.
 - Cardiovascular effects: pericarditis, pericardial effusion.

Clinical features

- Volume overload:
 - Shortness of breath.
 - Peripheral edema.
 - Rales in lung fields.
- Uremia:
 - Fatigue.
 - Anorexia, nausea, and vomiting.
 - Cramping.
 - Pruritus.
 - Altered mental status.
 - Asterixis.
- Acidosis:
 - Weakness.
 - Hyperventilation.
- Pericarditis with effusion and tamponade:
 - Classic presentation: JVD, muffled heart sounds, hypotension.
 - More commonly: chest pain, shortness of breath, lightheadedness, hypotension.

Diagnosis

- Clinical signs:
 - JVD.
 - Rales on pulmonary examination.
 - Peripheral edema.
 - S3 or gallop.
 - Hypertension.
- Radiographic signs:
 - Chest X-ray with cardiomegaly, vascular congestion, and effusions.
 - Cardiac ultrasound:
 - Performed to evaluate for pericardial effusion/tamponade:

- Hypoechoic, dark line of fluid around the pericardium, with right ventricular bowing as a sign of tamponade.
- Laboratory tests:
 - Elevated BUN and creatinine.
 - High potassium if acute or if missed dialysis.
 - Low bicarbonate.
 - Anemia.
- ECG:
 - May show signs of hyperkalemia:
 - Peaked T-waves → widening of the QRS and shortening of PR interval → wide QRS and disappearance of P waves → sine wave and ventricular fibrillation.
 - If cardiac tamponade is present:
 - Low voltage.
 - Electrical alternans.

Management

- Stabilize airway/breathing:
 - Non-invasive assisted ventilation can temporize breathing while medical management is initiated for fluid overload.
 - Intubation as needed.
- Treat hyperkalemia:
 - Stabilize the myocardium:
 - Calcium chloride/gluconate one ampule IV.
 - Force potassium intracellularly:
 - Regular insulin 10 units IV and glucose (D50) 1–2 ampules IV.
 - Sodium bicarbonate 50 meq IV over 5 min.
 - B₂ agonists: albuterol 10–20 mg nebulized.
 - Dialysis
 - Excrete potassium via the kidneys:
 - Furosemide 40–80 mg IV.
 - Excrete potassium via the intestines:
 - Sodium polystyrene sulfonate 30–60 g PO:
 - Does not work immediately.
- Treat pericardial effusion with tamponade:
 - Pericardiocentesis:
 - Ultrasound allows for direct visualization and a more direct, apical approach.

Debriefing plan

Plan ~30 min for discussion.

Potential questions for discussion

- Which labs will be abnormal in the setting of acute renal failure?
- What is the treatment for hyperkalemia?

- What are the indications for emergent dialysis?
- What are the clinical signs of pericardial effusion or tamponade?
- What findings on ultrasound would indicate tamponade, as opposed to effusion?
- When is pericardiocentesis indicated?

Selected reading

1. Alper AB. Uremia. <http://emedicine.medscape.com/article/245296-overview>. Updated March 17, 2010 (last accessed May 15, 2012).
2. Spangler S. Acute pericarditis. <http://emedicine.medscape.com/article/156951-overview>. Updated April 11, 2011 (last accessed May 15, 2012).
3. Sinert R. Renal and genitourinary disorders. In: Tintinalli JE, Kelen GD, Stapczynski JS, eds. *Emergency Medicine*. New York: McGraw-Hill, 2000.

CHAPTER 6 **Endocrine emergencies**

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Diabetic ketoacidosis

Educational goals

Learning objectives

Primary:

1. Recognize diabetic ketoacidosis (DKA) [*Medical Knowledge*].
2. Demonstrate appropriate management of DKA [*Medical Knowledge, Patient Care*].

Secondary:

1. Recognize and demonstrate correction of electrolyte abnormalities associated with DKA [*Medical Knowledge, Patient Care*].
2. Demonstrate professionalism and effective communication with consultants and ED nurse [*Interpersonal and Communication Skills, Professionalism*].
3. Demonstrate appropriate consultation with intensivist and direct proper disposition to the ICU [*Systems-based Practice*].

Critical actions checklist

- ☐ Assess airway, breathing, circulation (ABCs) [*Patient Care*]
- ☐ Correctly diagnose DKA [*Medical Knowledge*]
- ☐ Initiate administration of IVFs [*Medical Knowledge, Patient Care*]
- ☐ Initiate intravenous insulin therapy [*Medical Knowledge, Patient Care*]
- ☐ Search for cause of DKA: assess compliance with medications and evaluate for infection [*Medical Knowledge, Patient Care*]
- ☐ Diagnose urinary tract infection and order appropriate treatment [*Patient Care*]
- ☐ Call and communicate with ICU for disposition [*Interpersonal and Communication Skills, Professionalism*]

Simulation set-up

Environment: ED treatment area.

Mannequin: Simulator mannequin on a stretcher or hospital bed, male setup.

Props: To be displayed on plasma screen/computer screen or printed on handouts to be distributed when participants request test results:

- Images (see online component for Diabetic Ketoacidosis, *Scenario 6.1.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):

- Chest X-ray that is normal.
- ECG with sinus tachycardia.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Arterial blood gas (ABG).
 - Urinalysis.
 - Urine microscopy.

Available in the treatment room:

- Basic airway and code cart.
- Medications:
 - Insulin-labeled IV bag.
 - Ampules of 50% Dextrose (D50).
 - Labeled IV bag with antibiotic of choice to cover UTI.
- IVF:
 - NS.
 - 10% Dextrose (D10) drip.

Distractor: None.

Actors

- Paramedics are able to provide information about the scene. They found the patient in bed appearing unwell.
- The patient should sound sleepy and fatigued but he is able to answer questions appropriately.
- The ED nurse can start IV lines and administer medications/fluids. The nurse has some medical knowledge base and can cue learners if needed.
- An ICU physician can be available via “phone consultation.”

Case narrative

Scenario background

Mr Gerard is a 47-year-old man who called 911 because he was too weak to get out of bed. He told the responding EMS personnel that he has been feeling weak for several days. The patient states that he has been taking his insulin as usual, except that he did not eat yesterday, so he halved his insulin dose, according to his primary care physician's instructions. He reports increasing weakness and chills over the past 2–3 days, and also back pain and increased thirst. He says he has never experienced this before.

CC: Weak.

PMH: Diabetes, hypertension, hypothyroidism.

Meds: Regular insulin, levothyroxine, lisinopril, hydrochlorothiazide.

Option: To increase the difficulty of the case, the medication information can be unknown.

Allergies: None.

Family Hx: Mother died of aneurysm rupture.

Social Hx: No smoking, alcohol, or illicit drugs.

Initial scenario conditions

Patient is a sleeping, thin, middle-aged male who wakes to voice.

VS: Temp. 37.9 °C (100.2 °F), HR 125, RR 22, BP 95/60, O₂ sat 97% RA.

Eyes: Pupils are equal and reactive, conjunctivae are clear.

Mouth: Dry mucous membranes.

Heart: Tachycardia, no murmurs/rubs/gallops.

Lungs: Tachypnea, clear and equal lung sounds bilaterally.

Abdomen: Mild suprapubic tenderness (patient will cue this), otherwise normal.

Extremities: No leg edema, no calf tenderness to palpation.

Skin: Slightly clammy and cool (if learner asks).

Neurologic: Global weakness that does not lateralize. CN II–XII are grossly intact; non-focal strength/sensation examination (if the learners ask for focal deficit information, they can be told that the patient is weak but moves all four extremities).

The nurse may prompt any physical examination information that would not be obvious or shown on the mannequin.

See the flow diagram in Figure 6.1 for further scenario changes described below.

Case narrative, continued

Patient will respond with increasing alertness if 2 L or more of IVF are given.

Repeat vital signs after second liter will be as follows: VS: HR 115, RR 20, BP 98/65, O₂ sat 98% RA.

If the patient's urinary tract infection is not identified and treated after laboratory values are returned, the nurse can prompt the learner with, "Doctor, the patient feels warm." On re-check, the patient's temperature is 38.8°C (101.8°F).

If an insulin drip has not been started within 5 min after ABG results are returned, the patient becomes more acidotic and the respiratory rate increases from 22 to 40 breaths per minute. The patient can ask, "Why am I breathing so fast?"

For students and junior learners, the case can end after the patient has been admitted to the ICU. Advanced learners should continue on to treat hypoglycemia secondary to a medication error (see Phase II flow chart).

For advanced learners, once insulin has been administered, the patient becomes unresponsive and apneic. The nurse can cue the learner at this point: "The patient doesn't look so good. Mr Gerard, are you okay?" A fingerstick glucose test, if ordered, shows a level of 23 g/dL. If dextrose is not given within 2 min after the change in mental status, the blood pressure trends down over 5 min, until the patient has a ventricular fibrillation cardiac arrest. There will be no response to defibrillation or advanced cardiac life support medications until hypoglycemia is identified and treated.

When the patient stabilizes, the learner will be told that the nurse accidentally gave a bolus of 30 units of IV insulin before starting the insulin drip.

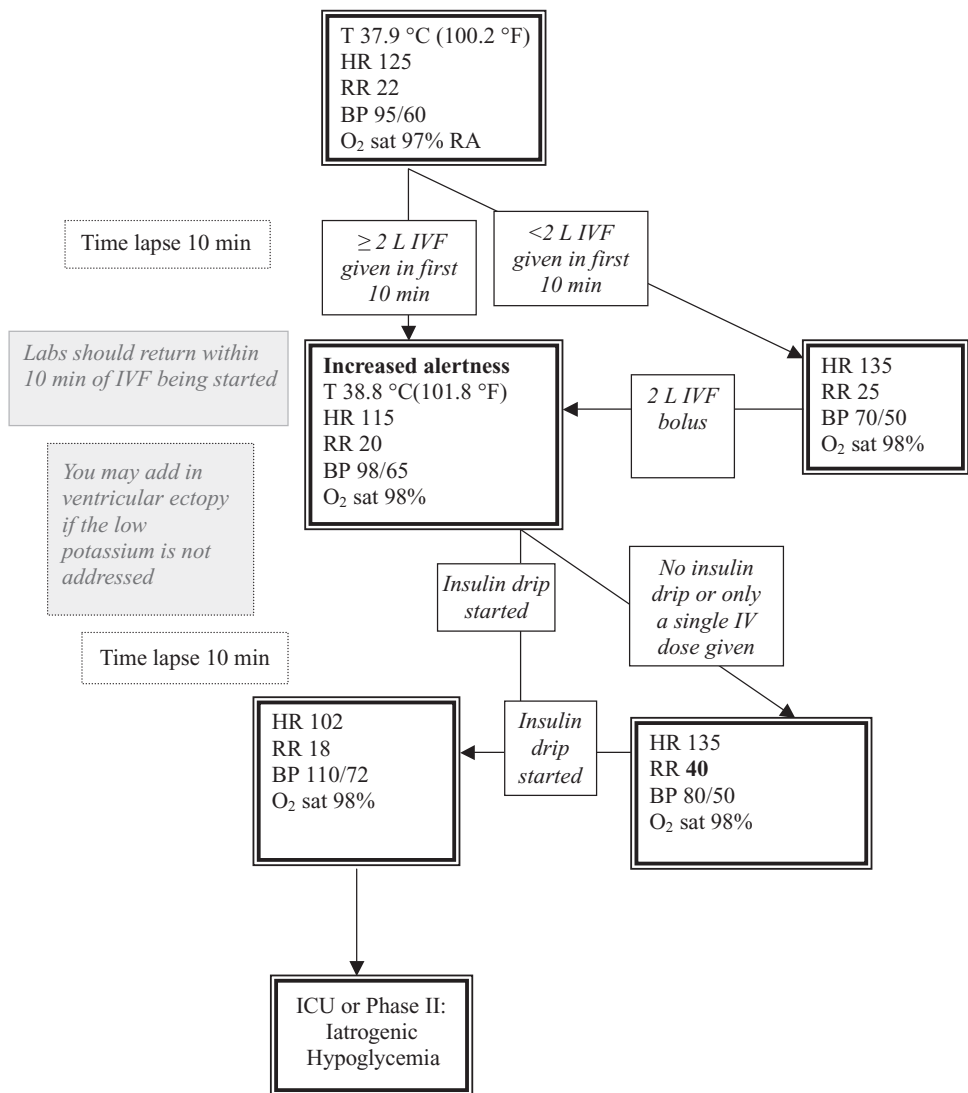


Figure 6.1 Scenario flow diagram: diabetic ketoacidosis.

Phase II for advanced learners: medication error due to IV insulin bolus

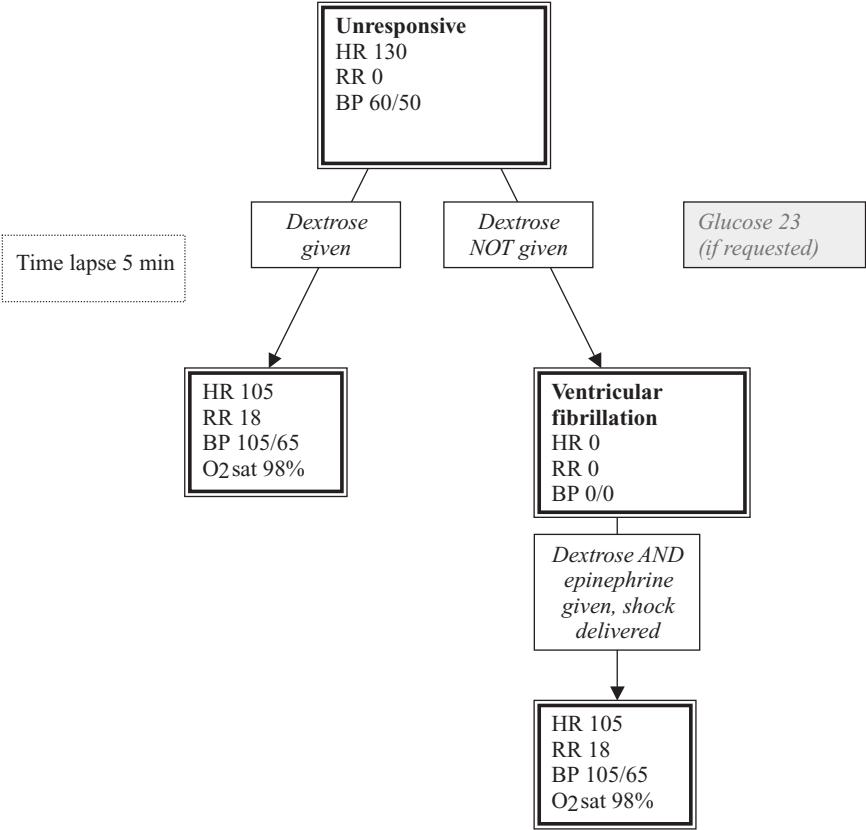


Figure 6.1 (Continued)

Instructor Notes

Background

- DKA is a life-threatening complication of diabetes:
 - Usually occurs with type 1 diabetes, but may be seen in type 2.
- Defined as uncontrolled diabetes associated with ketoacidosis.

Pathophysiology

- Non-compliance with insulin OR response to physiologic stress with increased insulin resistance causes hyperglycemia.
- Increased extracellular glucose → diuresis → dehydration.
- Decreased intracellular glucose → ketogenesis → acidosis.
- Decreased intracellular potassium → muscle weakness.
- Metabolic acidosis → hyperventilation for respiratory compensation.

Clinical features

- Dehydration.
- Tachycardia.
- Tachypnea secondary to attempted compensation for metabolic acidosis (Kussmaul respirations).
- Seizures, coma (in severe cases).
- Cerebral edema (rare); seen in <1% of children with DKA and extremely rare in adult patients:
 - Manifests as increasing headache, confusion, and lethargy.

Diagnosis

- Hyperglycemia, usually >250 mg/dL, but may be much higher.
- Serum bicarbonate <18 meq/L.
- Elevated anion gap.
- Elevated serum ketones.

Management

- Search for potential causes of DKA:
 - Infection.
 - Medication non-compliance.
 - Acute medical condition, e.g. stroke, myocardial infarction.
 - Stress response to physical trauma or recovery from surgery.
 - Recent corticosteroid use.
- Aggressive IVFs:
 - 3–5 L bolus of NS followed by continuous infusion at 15–20 mL/kg/h.
- Glucose management:
 - 0.1 unit/kg/h \pm 0.1 unit/kg bolus of regular insulin.
 - When the glucose level reaches 250–300 g/dL, change continuous IVF to D5 $\frac{1}{2}$ NS \pm 20 meq potassium chloride.

- Continue the insulin drip until the anion gap closes, then give subcutaneous insulin (0.1 unit/kg) 45 min before stopping the insulin drip.
- In select cases, uncomplicated DKA can be treated with subcutaneous insulin. The dosing schedule is as follows: insulin lispro, 0.3 unit/kg given as a subcutaneous bolus, followed by 0.2 unit/kg subcutaneously every 2 h.¹
- Electrolyte management:
 - Reassess potassium level and anion gap at regular intervals, typically hourly.
 - Add 20–30 meq/L of potassium chloride or potassium phosphate to the maintenance IVF if the initial potassium level is normal or low. The target serum potassium level is 4–4.5 meq/L, or follow the Lien–Spratt nomogram.²
- Sodium bicarbonate drip:
 - Consider for patients with pH <6.9 and altered mental status.
 - Add three ampules of bicarbonate to 1 L of sterile water; run at 150–300 mL/h.
 - Rarely used in pediatric patients, because of the increased risk of cerebral edema.

Debriefing plan

Allow ~30 min for discussion.

Potential questions for discussion

- What is the pathophysiology of DKA?
- What are some causes of DKA?
- How does DKA differ from non-ketotic hyperglycemia?
- What is the general emergency management of DKA?
- What are the expected electrolyte abnormalities in DKA (emphasis on hypokalemia and pseudohyponatremia)?

Selected reading

1. Mazer M, Chen E. Is subcutaneous administration of rapid-acting insulin as effective as intravenous insulin for treating diabetic ketoacidosis? *Ann Emerg Med* 2009;**53**:259–263.
2. Lien LF, Spratt SE, Woods Z, *et al.* Optimizing hospital use of intravenous insulin therapy: improved management of hyperglycemia and error reduction with a new nomogram. *Endocrine Pract* 2005;**11**:240–253.
3. Goldberg GA, Inzucchi SE. Critical issues in endocrinology. *Clin Chest Med* 2003;**24**:583–606.
4. Butler SO, Btaiche IF, Alaniz C. Relationship between hyperglycemia and infection in critical illness. *Pharmacotherapy* 2005;**25**:963–976.

Adrenal insufficiency

Educational goals

Learning objectives

Primary:

1. Identify adrenal insufficiency as a possible cause of hypotension, tachycardia, and hypoglycemia [*Medical Knowledge*].
2. Demonstrate proficiency in recognizing and confirming the diagnosis of adrenal insufficiency [*Medical Knowledge, Patient Care*].
3. Demonstrate appropriate management of adrenal insufficiency [*Medical Knowledge, Patient Care*].

Secondary:

1. Explain patient's medical condition and prognosis to concerned spouse [*Interpersonal and Communication Skills, Professionalism*].
2. Demonstrate professionalism and communication skills in consulting the ICU and working with ED nurse [*Interpersonal and Communication Skills, Professionalism*].
3. Demonstrate proper disposition/appropriate consultation [*Systems-based Practice*].

Critical actions checklist

- ☐ Assess airway, breathing, and circulation (ABCs) [*Patient Care*]
- ☐ Administer IVFs [*Patient Care*]
- ☐ Obtain a fingerstick glucose test [*Patient Care, Medical Knowledge*]
- ☐ Recognize adrenal crisis [*Patient Care, Medical knowledge*]
- ☐ Order cosyntropin stimulation test [*Patient Care, Medical Knowledge*]
- ☐ Initiate proper therapy for adrenal crisis: IV steroids (hydrocortisone or dexamethasone) [*Patient Care*]
- ☐ Call and communicate with admitting physician for disposition (a regular inpatient floor bed if the patient could be treated adequately or ICU bed if resuscitation was not adequate) [*Patient Care, Interpersonal and Communication Skills, Professionalism*]

Simulation set-up

Environment: ED treatment area.

Mannequin: Simulator mannequin on a stretcher or hospital bed, male set-up.

Props: To be displayed on plasma screen/computer screen or printed on handouts and distributed in the scenario room when the participants ask for laboratory results:

- Images (see online component for Adrenal Insufficiency, *Scenario 6.2.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - Chest X-ray that shows normal cardiac silhouette.
 - ECG with sinus tachycardia.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Arterial blood gas.
 - Cortisol level
 - Cortisol level after cosyntropin stimulation test. This level will not return for 1 h if the learner asks for a result.
 - Urinalysis

Available in the treatment room:

- Basic airway and code cart.
- Medications:
 - Cosyntropin, 250 µg IV labeled in syringe.
 - Dexamethasone-labeled IV bag.
 - Hydrocortisone-labeled IV bag.
 - Ampules of 50% dextrose solution (D50).
- IVF:
 - Normal saline (NS) in labeled liter bags.
 - 5% dextrose in 0.45% NS (D5 $\frac{1}{4}$ NS) in labeled liter bags.
 - 5% dextrose in water or NS in labeled bag.
 - 10% dextrose in water or NS in labeled bag.

Distractor: None.

Actors:

- The wife provides history at the beginning of the case.
- The patient is initially just moaning, but he becomes more alert after hypoglycemia is treated and is able to provide more history.
- The ED nurse can start IV lines and administer medications/fluids. The nurse has some medical knowledge base and can cue learners if needed.
- An ICU physician can be available via “phone consultation.”

Case narrative

Scenario background

The wife explains that she and the patient are traveling through the area from another state. While they were driving on the interstate highway, the patient began to complain of palpitations and weakness. She tells the learner that they left two medicine bottles at home; one was pain medication but they aren't sure what the other was (perhaps prednisone).

CC: Weakness and palpitations.

PMH: Hypertension, chronic pain, systemic lupus erythematosus.

Meds: Hydrochlorothiazide, lisinopril, oxycodone/acetaminophen, prednisone.

Option: To increase the difficulty of the case, make the medication information unknown or refer to prednisone as "something for my lupus."

Allergies: None.

Family Hx: Mother with history of multiple pulmonary emboli, father died of a heart attack at 64 years of age.

Social Hx: No smoking, occasional alcohol, no illicit drugs.

Initial scenario conditions

A middle-aged male who moans occasionally.

VS: Temp. 37.3 °C (97.5 °F), HR 123, RR 14, BP 85/50, O₂ sat 96% RA.

Eyes: Pupils are equal, round, and reactive to light.

Heart: Tachycardia, no murmurs.

Lungs: Equal bilaterally, clear to auscultation.

Abdomen: Soft, no masses, non-tender.

Extremities: Skin is cool and clammy, no edema.

Neuro: Moans to painful stimuli and has a gag reflex; moves all four extremities to pain but does not follow commands.

Any examination findings that are not available on your mannequin should be reported by the nurse when the learner asks or examines the patient for them.

See the flow diagram in Figure 6.2 for further scenario changes described below.

Case narrative, continued

If the glucose level is checked initially, it is 43 g/dL. After an ampule of D50 is administered, the patient regains normal mental status but continues to be tachycardic and hypotensive. He is now able to give a history of increasing palpitations and weakness. He has not taken two of his medications for the past 2 days because he and his wife have been traveling. If the learner asks, the patient has had no access to insulin or oral diabetic medications.

If the patient does not receive at least 2 L of IVF and IV corticosteroids, he becomes increasingly tachycardic and hypotensive and goes into pulseless electrical activity that responds to epinephrine and steroids. If steroids are not ordered by the learner, the consultant may prompt the learner for the diagnosis and suggest this approach.

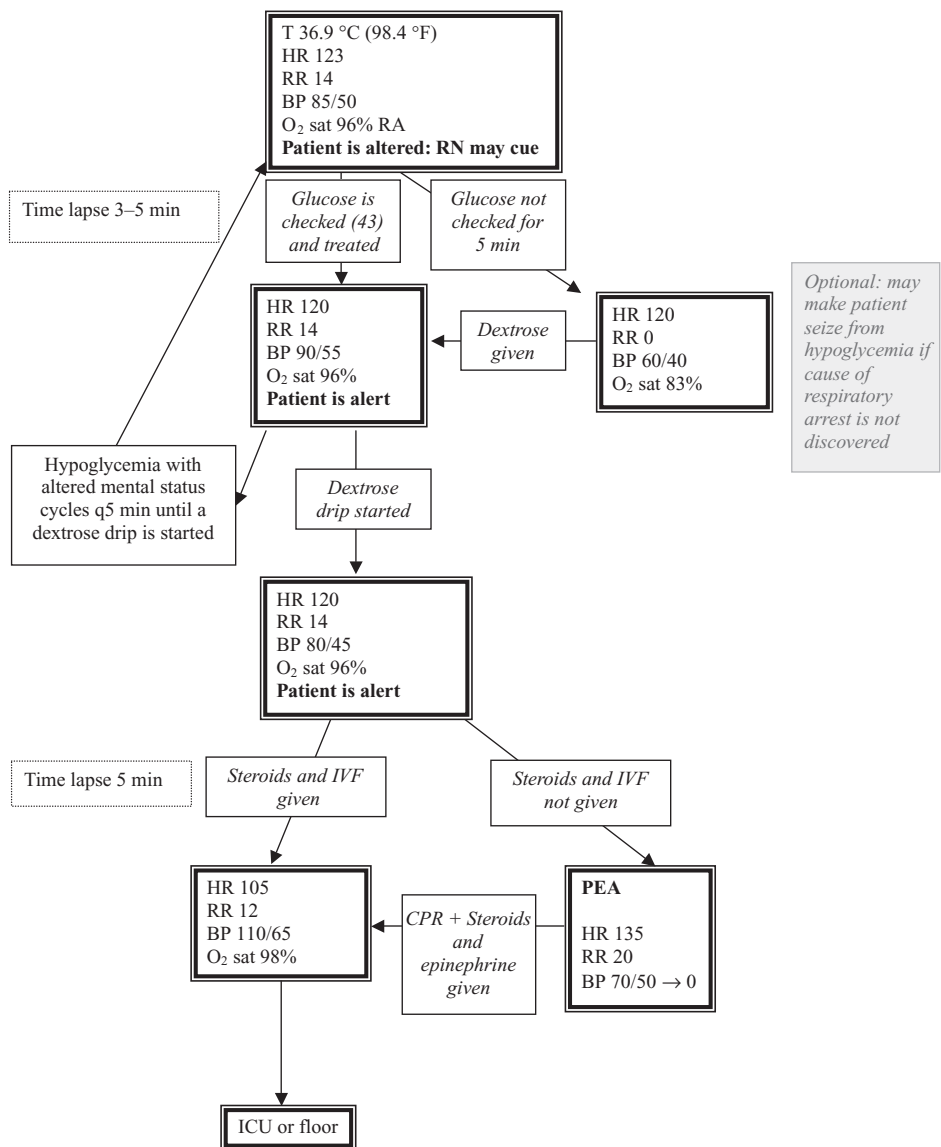


Figure 6.2 Scenario flow diagram: adrenal insufficiency.

Instructor notes

Pathophysiology

Two major types of adrenal insufficiency can lead to adrenal crisis:

- Primary adrenal insufficiency, caused by destruction of the adrenal gland:
 - Autoimmune.
 - Traumatic adrenal hemorrhage.
 - Infectious.
- Secondary adrenal insufficiency, caused by suppression of the hypothalamic pituitary adrenal (HPA) axis by prolonged use of exogenous steroids (more common).

Clinical features

- Severe fatigue.
- Hypotension.
- Electrolyte abnormalities:
 - Hyponatremia.
 - Hypoglycemia.
 - Hyperkalemia.

Diagnosis

- Adrenocorticotrophic hormone (ACTH) stimulation test with cosyntropin (an ACTH analog) is confirmatory.
- Cosyntropin stimulation test:
 - Draw baseline cortisol level.
 - Administer 250 µg of IV cosyntropin.
 - Draw repeat cortisol level at 60 min.
 - Adrenal insufficiency is unlikely with the following:
 - Basal cortisol level >25 µg/dL.
 - Cortisol levels that increase twofold or more 60 min after cosyntropin is given.

Management

- Corticosteroids:
 - Dexamethasone, 0.1 mg/kg IV, given if a cosyntropin test is being performed
 - OR
 - Hydrocortisone, 100 mg IV.
- Glucose maintenance:
 - D50 boluses for stabilization of hypoglycemia.
 - Maintenance IV drip of D5–D10 in water or NS until steroids are given.
- ECG to evaluate for hyperkalemia.
- Sodium: treat hyponatremia with NS maintenance fluid.
- Infectious workup: evaluate for source of inciting infection, including chest X-ray, urinalysis, and lumbar puncture when evidence of meningitis is present (Waterhouse–Friderichsen syndrome).

Debriefing plan

Allow ~30 min for discussion.

Potential questions for discussion

- What are the signs and symptoms of adrenal insufficiency?
- What types of patients are at risk for adrenal insufficiency?
- Should this patient be started on early goal-directed therapy for sepsis?
- If this patient remained hypotensive after steroids were given, what is the best vasopressor to use?

Selected reading

1. Torrey S. Recognition and management of adrenal emergencies. *Emerg Med Clin North Am* 2005;**23**:687–702.
2. Goldberg GA, Inzucchi SE. Critical issues in endocrinology. *Clin Chest Med* 2003;**24**:583–606.
3. Marini JJ. Endocrine emergencies: adrenal diseases. In: Marini JJ, Wheeler AP, eds. *Critical Care Medicine*, 3rd edn. Philadelphia: Lippincott Williams & Wilkins, 2006, pp. 518–521.

Thyroid storm

Educational goals

Learning objectives

Primary:

1. Recognize thyrotoxicosis as the cause of this patient's symptomatology [*Medical Knowledge*].
2. Perform initial stabilization of thyrotoxicosis with appropriate medications in the correct sequence: β -blocker, methimazole, iodine, and dexamethasone [*Medical Knowledge, Patient Care*].

Secondary:

1. Understand that amiodarone can cause thyrotoxicosis [*Medical Knowledge*].
2. Demonstrate professionalism and communication skills in consulting the ICU and working with ED nurse [*Interpersonal and Communication Skills, Professionalism*].
3. Call and communicate effectively with the ICU for disposition [*Interpersonal and Communication Skills, Professionalism, Systems-based Practice*].

Critical actions checklist

- ☐ Assess airway, breathing, circulation (ABCs) [*Patient Care*]
- ☐ Obtain 12-lead ECG to determine rhythm and recognize atrial fibrillation [*Medical Knowledge*]
- ☐ Send thyroid panel to evaluate for thyroid storm [*Medical Knowledge*]
- ☐ Initially treat patient with β -blocker to stabilize hemodynamics [*Medical Knowledge, Patient Care*]
- ☐ Initiate proper therapy following β -blocker: give methimazole/propylthiouracil (PTU), iodine, and corticosteroid [*Medical Knowledge, Patient Care*]
- ☐ Call and communicate with ICU for disposition [*Interpersonal and Communication Skills, Professionalism, Systems-based Practice*]

Simulation set-up

Environment: ED treatment area.

Mannequin: Simulator mannequin on a stretcher or hospital bed; male setup.

Props: To be displayed on plasma screen/computer screen or printed on handouts to be distributed when participants ask for laboratory results:

- Images (see online component for Thyroid Storm, *Scenario 6.3.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - Chest X-ray showing cardiomegaly and pulmonary edema.
 - ECG showing sinus tachycardia.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Cardiac enzymes.
 - Brain natriuretic protein (BNP).
 - Thyroid studies.
 - Arterial blood gas.
 - Urinalysis.

Available in treatment room:

- Basic airway and code cart.
- Medications:
 - Furosemide-labeled syringe.
 - β -Blocker (metoprolol, labetalol, or esmolol).
 - Corticosteroid (dexamethasone or hydrocortisone).
 - Methimazole or propylthiouracil.
 - Lugol's solution.
- IVF:
 - Normal saline in liter bags.

Real medications need not be used; they can be represented with labeled syringes or medication bottles.

Distractor: Optional. Girlfriend may be disruptive to test the more advanced learner's professionalism and communication skills.

Actors:

- The girlfriend can give a small amount of history and knows that the patient just started a drug that starts with an "a" (amiodarone) because he had a dangerous heart rhythm.
- Patient voice is male. Patient should be tachypneic and anxious.
- ED nurse can start IV lines and administer medications/fluids. The nurse has some medical knowledge base and can cue learners if needed.

- An ICU physician can be available via “phone consultation.”
- An endocrinologist can be available via “phone consultation.”

For more advanced learners, make the ICU physician unavailable until the condition is diagnosed and the patient is stabilized. For novice learners, the ICU physician can provide advice over the telephone before accepting the admission.

Case narrative

Scenario background

The patient is a 43-year-old man who arrives at the ED by private vehicle with his girlfriend. He complains of severe chest discomfort, shortness of breath, palpitations, and anxiety. He has never experienced these symptoms before. He was recently hospitalized for episodes of ventricular tachycardia of unknown cause; he refused defibrillator placement and was discharged on amiodarone.

The information about the recent hospitalization can be withheld from more advanced learners.

CC: Palpitations, shortness of breath, severe anxiety.

PMH: Depression, hypertension, paroxysmal ventricular tachycardia (information may be withheld).

Meds: Paroxetine, hydrochlorothiazide, amiodarone.

Allergies: None.

Family Hx: Unknown, patient was adopted.

Social Hx: Tobacco abuse, rare alcohol, no drugs.

Initial scenario conditions

Alert middle-aged man in mild respiratory distress.

VS: Temp. 37.8 °C (100 °F), HR 135, RR 22, BP 163/75, O₂ sat 94% RA.

Eyes: Anicteric, pupils are equal at 4–5 mm.

Neck: Significant jugular venous distension, no thyromegaly.

Heart: Tachycardic; irregular; no murmurs, rubs, or gallops.

Lungs: Bibasilar rales.

Abdomen: Soft, non-tender.

Extremities: Normal, non-tender, no edema.

Skin: Warm, sweaty.

Neuro: Alert and oriented to person, place, and time; no focal deficits.

See the flow diagram in Figure 6.3 for further scenario changes described below.

Case narrative, continued

If a β -blocker is not given, the patient goes into supraventricular tachycardia (SVT). After a β -blocker has been administered or if synchronized cardioversion is delivered, the patient improves.

At this point in the scenario, three medications should be ordered: (1) methimazole/PTU and (2) a corticosteroid, followed 1 h or more later by (3) iodine. None of these drugs causes significant changes in the vital signs because of their long onset of clinically appreciable effect. However, junior learners should be prompted by the ICU physician or nurse to give methimazole or PTU (the next drug to be given after the β -blocker), and more advanced learners should list all three to be given to complete the scenario.

If the appropriate medications are not ordered by the advanced learner, he or she can be told that the patient's room is being cleaned, so the patient must continue to be managed in the ED. If appropriate medications are still not given, the nurse or admitting physician can prompt the learner to consult an endocrinologist, who will make the appropriate recommendations.

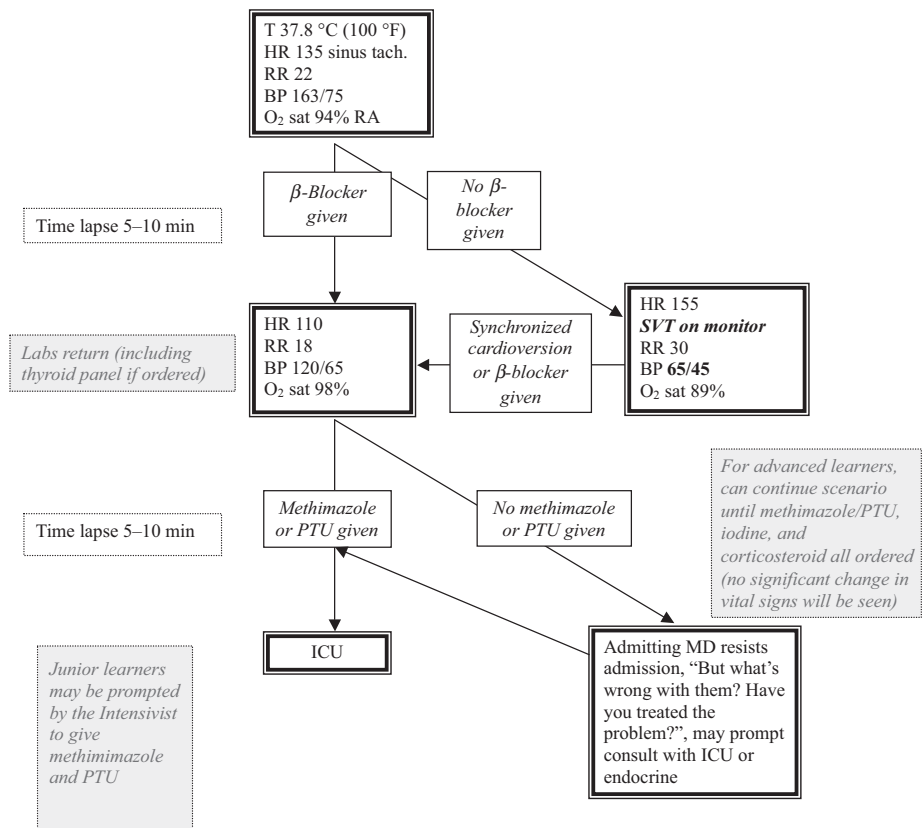


Figure 6.3 Scenario flow diagram: thyroid storm.

Instructor notes

Pathophysiology

- The thyroid gland provides important control of metabolism with a multi-step process of hormone release and negative feedback:
 - Thyroid-releasing hormone (hypothalamus) → thyroid stimulation hormone (anterior pituitary) → thyroid hormone (thyroid gland).
- Causes of thyrotoxicosis are as follows:
 - Diffuse toxic goiter (Graves' disease).
 - Thyrotoxic phase of subacute thyroiditis.
 - Toxic multinodular goiter (Plummer's disease).
 - Toxic adenoma.
 - Amiodarone-induced thyrotoxicosis (AIT) (3% of patients on amiodarone):
 - Amiodarone contains a significant amount of iodide (75 mg iodide per 200 mg tablet) and is toxic to thyroid cells.
 - May take 2–3 years of use to develop.
 - Two types of AIT:
 - Type 1 occurs in iodine-deficient areas when the thyroid gland is stimulated by large iodide doses and increases release of T4.
 - Type 2 is most common in developed areas, where patients have normal iodide levels. Amiodarone destroys the thyroid gland, leading to T4 release.

Clinical features

- Tachycardia.
- Hypertension.
- Hyperthermia.
- New-onset atrial fibrillation.
- New tremor.
- Weight loss.
- Heat intolerance.

Diagnosis

- A thyroid panel will show a normal or low TSH level, a normal or high level of T3, and markedly high levels T4.

Management

Order of treatment is important:

1. Stabilize hemodynamics by blunting adrenergic effects of thyroid hormone:
 - Propranolol is preferred.
 - Esmolol as a drip.
2. Inhibit synthesis of new thyroid hormone and/or conversion of T4 to T3:
 - Methimazole halts further production of T4 but does not prevent conversion of existing T4 to T3:
 - The preferred initial agent in most cases.
 - Teratogenic.

- Propylthiouracil decreases iodine trapping, production of thyroid hormone, and conversion of T4 to T3 peripherally:
 - More hepatotoxic but safer for pregnant patients.
 - Dexamethasone decreases conversion of T4 to T3 in the periphery.
3. Prevent release of stored thyroid hormone:
 - Iodine provides negative feedback to halt thyroid hormone release:
 - Use Lugol's solution (iodine/potassium iodide) or IV contrast dye.
 - Wait at least 1 h after giving PTU/methimazole so that iodine is not used to make more thyroid hormone.
 4. Correct fluid status and electrolytes:
 - Treat with aggressive boluses of IVFs when possible.
 - Patients with evidence of congestive heart failure and fluid overload can be treated with diuretics.
 - Up to 30% of thyrotoxic patients have hypercalcemia because thyroid hormone induces osteoclast activity.
 5. Diagnose and treat the underlying cause of thyroid storm:
 - Infection.
 - Thyroid surgery in patients with subclinical hyperthyroidism.
 - Excessive levothyroxine intake.
 - Radioactive iodine treatment.
 - Pregnancy.
 - Cessation of prescribed PTU or methimazole.

Debriefing plan

Allow ~30 min for discussion.

Potential questions for discussion

- What kinds of physical examination findings might you see in a patient with hyperthyroidism?
- What predisposed this patient to thyrotoxicosis?
- Name some causes of thyrotoxicosis.
- What is apathetic thyrotoxicosis and who gets it?
- What kinds of electrocardiographic changes might you see in thyrotoxicosis?
- What is the treatment of thyrotoxicosis? In what order should interventions be performed?

Selected reading

1. Goldberg GA, Inzucchi SE. Critical issues in endocrinology. *Clin Chest Med* 2003;**24**:583–606.
2. Tsang W, Houlden RL. Amiodarone-induced thyrotoxicosis: a review. *Can J Cardiol* 2009;**25**:421–424.
3. Chattaway JM, Klepser TB. Propylthiouracil versus methimazole in treatment of Graves' disease during pregnancy. *Ann Pharmacother* 2007;**41**:1018–1022.
4. Nakamura H, Noh JY, Itoh K, *et al*. Comparison of methimazole and propylthiouracil in patients with hyperthyroidism caused by Graves' disease. *J Clin Endocrinol Metab* 2007;**92**:2157–2162.
5. Stathatos N, Wartofsky L. Thyrotoxic storm. *J Intensive Care Med* 2002;**17**:1–7.

CHAPTER 7 **Environmental emergencies**

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Carbon monoxide toxicity with hypothermia

Educational goals

Learning objectives

Primary:

1. Identify clinical signs of carbon monoxide (CO) toxicity and hypothermia [*Medical Knowledge*].
2. Initiate appropriate treatment for CO toxicity and hypothermia [*Medical Knowledge, Patient Care*].

Secondary:

1. Exhibit professional interactions with ED staff and consultants. [*Interpersonal and Communication Skills, Professionalism*].
2. Demonstrate ability to disposition patient appropriately [*Systems-based Practice*].

Critical actions checklist

- ☐ Place patient on cardiac monitor and pulse oximetry [*Patient Care*]
- ☐ Assess rectal temperature [*Patient Care*]
- ☐ Administer oxygen [*Patient Care*]
- ☐ Order electrocardiogram (ECG) and identify Osborn waves; correlate finding with hypothermia [*Medical Knowledge*]
- ☐ Initiate active external and non-invasive internal rewarming therapies (warm fluids, warming blankets) [*Medical Knowledge, Patient Care*]
- ☐ Order initial laboratory studies, including co-oximetry panel [*Medical Knowledge*]
- ☐ Contact critical care physician regarding hyperbaric oxygen therapy and intensive care unit (ICU) admission [*Medical Knowledge, Interpersonal and Communication Skills, Professionalism*]

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin on a stretcher. The simulator is female and should be wearing multiple layers of clothing.

Props: To be displayed on monitor or printed out as handouts to be provided upon request:

- Images (see the online component for Carbon Monoxide Toxicity with Hypothermia, *Scenario 7.1.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG with Osborn waves.
 - Chest X-ray, portable view, showing normal findings.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Liver function tests.
 - Coagulation panel.
 - Co-oximetry panel.
 - Toxicology levels: acetaminophen, salicylate, ethanol.
 - Cardiac enzymes.
 - Urine drug screen.

Available in the treatment room:

- Standard airway equipment.
- Code cart with standard ACLS medications.
- Rewarming devices: humidified oxygen, warm intravenous fluids (IVF), Bair Hugger™, or other institution-specific warming devices.
- IVF [0.9% normal saline (NS) and 5% dextrose in water (D5W)].
- Rectal thermometer.
- Equipment for chest tube thoracostomy (optional).
- Equipment for bladder irrigation (optional).
- Equipment for peritoneal cavity irrigation (optional).

Distractor: None.

Actors:

- Paramedics can provide information about the scene, including that the house felt cold.
- Husband arrives shortly after paramedics and may provide patient history.
- Patient voice should be female. Patient should only mumble.
- ED nurse can start IVs and connect patient to the monitor. The nurse may cue learners if needed.
- Critical care specialist is available by telephone. This individual is trained in hyperbaric therapy, but does not offer this therapy unless it is first suggested by the learner.

Case narrative

Scenario Background

A 39-year-old female found by her husband lying on the kitchen floor. He noted that their house needs more insulation, as it “always seems cold in there.” His wife was in her normal state of health when he left for work that morning. When her husband found her, he initially thought she was sleeping; she only mumbled and has not yet spoken. Her husband mentioned that they lost power overnight and when he returned home he found the oven door ajar with the pilot light still running.

Paramedics should present background information with the husband adding additional information.

CC: Altered mental status.

PMH: Hypothyroidism.

Meds: Levothyroxine.

Allergies: None.

Family Hx: Non-contributory.

Social Hx: Social alcohol, no smoking or illicit drugs.

Initial Scenario conditions

Patient is minimally conscious and only mumbles to painful stimuli.

VS: Rectal temp. 30.7°C (87.3°F), HR 42, RR 26, BP 104/64, O₂ sat 99% RA (if the learner does not specifically ask for a rectal temperature then the nurse should prompt “I’m just getting ‘low’ on the thermometer being used”).

Eyes: Pupils equal, round, and sluggishly reactive to light.

Heart: Bradycardic but otherwise no murmurs, rubs, or gallops.

Lungs: Breath sounds decreased bilaterally but equal.

Neuro: Lethargic, only mumbles to painful stimuli. Pupils are 4 mm and sluggishly reactive. Remaining cranial nerves difficult to assess based on the patient’s mental status. Moves all extremities spontaneously but difficult to assess strength. Withdraws to painful stimuli. Speech is mumbled.

Examination findings not reproducible on a particular mannequin can be relayed verbally by the nurse once requested by the learner.

See the flow diagram in Figure 7.1 for further scenario changes described below.

Case narrative, continued

The patient continues to be lethargic if *both* non-invasive internal rewarming and active external rewarming are not initiated. If, after 5 min, both types of rewarming are not initiated, the patient's body temperature will drop to a point that requires active core rewarming measures. If learners fail to warm the patient appropriately, she will have a PEA arrest.

The case can be made more difficult for advanced learners by making the starting temperature lower so that invasive internal warming measures are required initially.

Approximately 5 min into the case, any requested laboratory and imaging results should be available. If the learners do not order a carboxyhemoglobin level, the patient's husband may cue them by inquiring, "Could the gas from the oven make her act like this?" The learners should review the results and place the patient on 100% oxygen (if she is not already receiving this therapy).

Once the patient has been rewarmed and received oxygen, the learner should consult for hyperbaric therapy and admission. If the hyperbaric consultation does not occur or if appropriate oxygen therapy is not initiated, this may be cued by the admitting doctor.

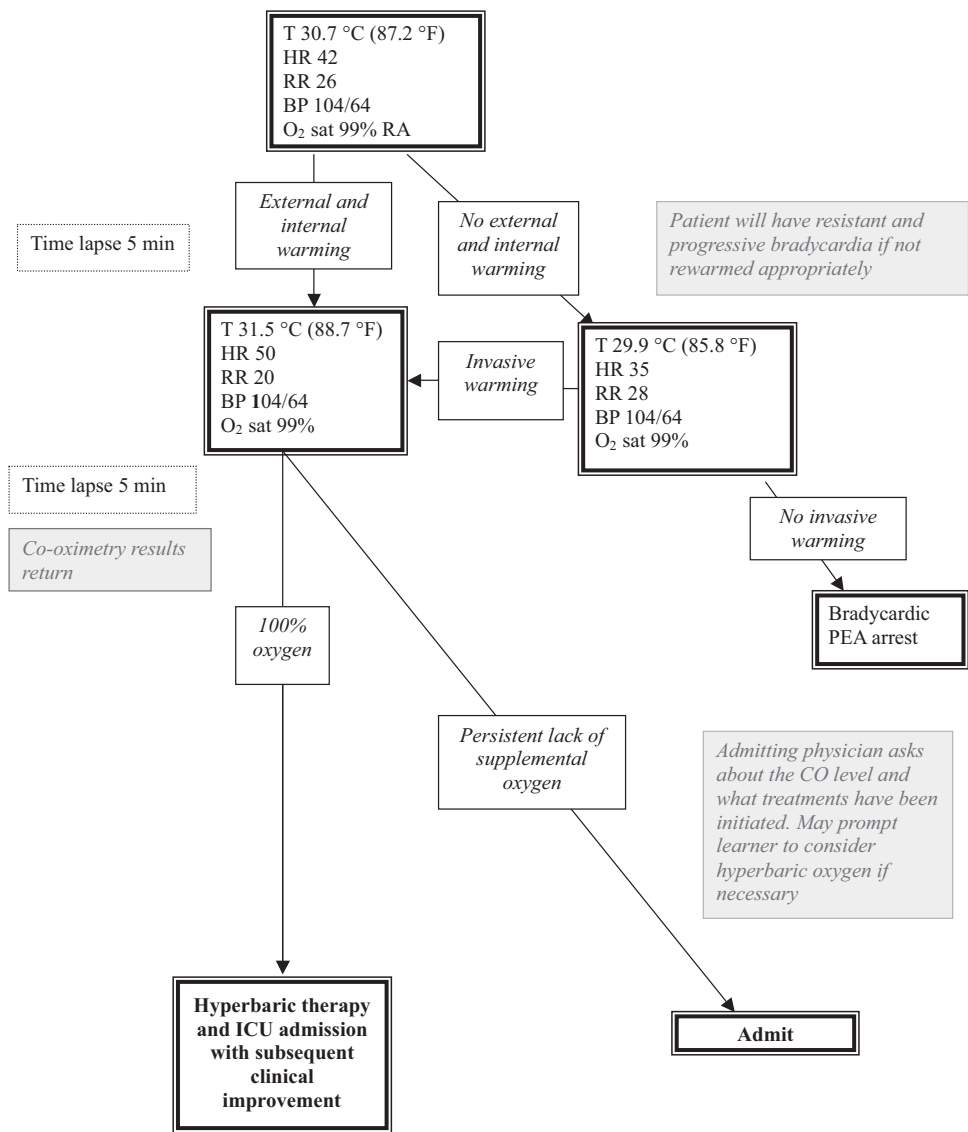


Figure 7.1 Scenario flow diagram: carbon monoxide toxicity with hypothermia.

Instructor notes: CO toxicity**Pathophysiology**

- More common in colder months (use of accessory heating methods).
- Colorless, odorless gas.
- Baseline levels in ambient air: 10 parts per million (ppm).
- Clinical effects common with levels >100 ppm.
- CO binds to hemoglobin with significantly higher affinity than oxygen, thus blocking oxygen transfusion to cells (oxygen dissociation curve shifts left):
 - Fetal hemoglobin binds CO with even greater affinity than does adult hemoglobin.

Clinical features

- Headache, visual changes, altered mental status, seizures, syncope, cardiac disturbances, dyspnea, neurologic abnormalities.
- Clinical features do not necessarily increase with increasing co-oximetry readings.

Diagnosis

- Co-oximetry panel (venous or arterial sample) showing elevated CO level.
- Pulse oximetry levels do not correlate with CO.
- Anion gap metabolic acidosis.
- Elevated lactate.
- Positive troponin may be seen but is not necessary to make the diagnosis.

Management

- Supplemental high-flow oxygen via 100% non-rebreather mask.
- Consider hyperbaric oxygen therapy. Indications:
 - Altered mental status.
 - Neurologic abnormalities.
 - Cardiac ischemia.
 - Syncope.
 - Carboxyhemoglobin level >25% (>15% in pregnancy).
- Admission; medical floor versus ICU based on extent of CO elevation and medical co-morbidities.

Instructor notes: hypothermia**Pathophysiology**

- Mild: body trying to increase core temperature; cardiac output increases, shivering still possible.
- Moderate: shivering stops, metabolic processes start to slow.
- Severe: metabolic processes essentially stop.

Clinical features

- Cardiac conduction disturbances:
 - Prolonged PR, QRS, or QT.

- Bradycardia.
- Atrial fibrillation.
- Atrioventricular (AV) block.
- Premature ventricular contraction (PVC).
- Osborn (J waves):
 - Positive deflection of terminal aspect of QRS complex.
- Ventricular fibrillation.
- Diuresis (due to abnormal renal filtration rates).

Diagnosis

- Core temperature measurement (rectal probe, Foley catheter, esophageal probe):
 - $>35^{\circ}\text{C}$: normothermic.
 - $32\text{--}35^{\circ}\text{C}$: mild hypothermia.
 - $30\text{--}32^{\circ}\text{C}$: moderate hypothermia.
 - $<30^{\circ}\text{C}$: severe hypothermia.

Management

- Mild hypothermia:
 - Passive rewarming:
 - Remove wet clothing.
 - Bring patient indoors.
 - Blankets.
- Moderate hypothermia:
 - Active external rewarming:
 - Heating devices (electric blankets).
 - Forced heat (Bair HuggerTM).
 - Non-invasive internal rewarming:
 - Warm IV fluids.
 - Warm humidified air.
- Severe hypothermia:
 - Active core rewarming:
 - Warm IV fluids
 - Warm fluid body cavity irrigation:
 - Thoracotomy/thoracostomy.
 - Bladder (via Foley catheter).
 - Peritoneal (via peritoneal lavage).

Debriefing plan

Plan ~30 min for discussion.

Potential questions for discussion

- What time of year is CO toxicity most likely to occur?
- What is the physiology of oxygen binding in CO toxicity?
- Why are pregnant women and their fetuses at higher risk of CO toxicity?
- What are the indications for hyperbaric therapy in treating CO toxicity?

- What are the classifications of hypothermia?
- What are the appropriate rewarming methods for hypothermia?

Selected reading

1. Polderman KH. Mechanisms of action, physiological effects, and complications of hypothermia. *Crit Care Med* 2009;**37**(7 Suppl):S186–202.
2. Buckley NA, Isbister GK, Stokes B, Juurlink DN. Hyperbaric oxygen for carbon monoxide poisoning: a systematic review and critical analysis of the evidence. *Toxicol Rev* 2005;**24**(2):75–92.

Snake bites

Educational goals

Learning objectives

Primary:

1. Identify clinical signs of snake envenomation [*Medical Knowledge*].
2. Initiate appropriate treatment for snake envenomation [*Medical Knowledge, Patient Care*].

Secondary:

1. Exhibit professional interactions with ED staff and consultants [*Interpersonal and Communication Skills, Professionalism*].
2. Demonstrate ability to disposition patient appropriately [*Systems-based Practice*].

Critical actions checklist

- ☐ Place patient on cardiac monitor and administer IV fluids [*Patient Care*]
- ☐ Recognize signs of snake bite [*Medical Knowledge*]
- ☐ Order basic laboratory studies including coagulation studies, fibrinogen, and fibrinogen split products [*Medical Knowledge*]
- ☐ Consult local poison center [*Medical Knowledge*]
- ☐ Initiate proper antivenom therapy [*Medical Knowledge*]
- ☐ Call and communicate to general medical floor team or ICU for disposition [*Interpersonal and Communication Skills, Professionalism*]

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin should be female. The simulator should be lying on a stretcher, wearing shorts, a T-shirt and hiking boots. The left lower extremity should be immobilized in a splint. Moulage should be applied to the left lower extremity just above the edge of the boot to create the appearance of a snakebite by applying an area of erythema 5×3 cm (oval) to the lateral aspect of the lower leg 2 cm superior to the edge of her hiking boot. Two violaceous punctate lesions (~ 0.5 cm apart) should be applied in the middle of the area of erythema. Swelling can be moulaged by placing a wet diaper underneath the tibia skin.

Props: To be displayed on a monitor or printed out as handouts to be provided upon request:

- Imaging (see the online component for Snake Bites, *Scenario 7.2.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - Report of ECG with sinus tachycardia.
 - Report of left lower leg X-ray with soft tissue swelling but no fracture.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Liver function tests.
 - Fibrin studies: fibrinogen, fibrinogen split products.
 - Coagulation panel.

Available in the treatment room:

- Standard airway equipment, including oxygen and masks.
- Code cart with ACLS medications.
- Medications (labeled bags/syringes may be used in place of actual medicine syringes or bags):
 - IVF [0.9% normal saline (NS) and 5% dextrose in water (D5W)].
 - Polyvalent immune Fab.

Distractor: None.

Actors:

- Paramedics provide a report the patient's hemodynamic status during transportation, but they have little information about events that occurred before their arrival. They report that they were able to immobilize the extremity with standard padded pre-hospital splinting. An 18 gauge IV was placed in the right antecubital fossa. The patient has received ~ 1 L of IV fluid and morphine 4 mg IV.
- Hiking partner(s) relay that they were hiking Camelback Mountain in Phoenix, AZ. They report hearing a rattling sound and then the patient felt a stinging sensation to her left lower extremity. Two members of the group stayed with the patient and elevated her leg while two others went to get help.

The location could be changed to the East coast of the United States and present as a coral snake bite with symptoms consisting of parathesias, mild swelling, AMS, and cranial nerve dysfunction (difficulty swallowing, diplopia, ptosis).

- The patient is a female. Her voice should be clear. She notes increasing pain to her left lower extremity. After 5 min she notes that her mouth has a “pins and needles feeling.”
- ED nurse can start IVs, administer medications and fluids, and comfort the patient. The nurse does have some medical knowledge base and may cue learners if needed.
- Poison control center, orthopedics physician consultant, and ICU physician can be available via telephone consultation.

Case narrative

Scenario background

A 27-year-old female is brought in by EMS after the sudden onset of pain while hiking down Camelback Mountain (Phoenix, AZ). She thought she heard something rattling and then had the immediate onset of pain to her left lower leg. She was not able to continue hiking due to pain. Her friends elevated her leg while awaiting help. If asked, last tetanus shot was 2 years ago.

Background may be presented prior to case, by EMS, by hiking partners, or by triage sheet.

CC: Sudden onset of pain to the left lower extremity.

PMH: None.

Meds: Oral contraceptive (does not remember the name).

Allergies: None.

Family Hx: Non-contributory.

Social Hx: Social alcohol, denies tobacco and illicit drugs.

Initial scenario conditions

Alert female with her left lower leg immobilized and elevated. She is complaining of pain in her left lower extremity.

VS: Temp. 37.1 °C (98.8 °F), HR 130, RR 18, BP 80/48, O₂ sat 98% RA.

Heart: Tachycardic but regular, no murmurs, rubs, or gallops.

Lungs: Clear to auscultation bilaterally.

Extremities: Left lower leg splinted with an area of significant swelling and erythema with central punctate lesions. Compartments soft.

Neurologic: Cranial nerves intact. Strength 5/5 bilateral upper extremities, right lower extremity. Difficult to assess strength of left lower leg secondary to pain. Sensation is intact to light touch in all four extremities.

Skin: As per extremity examination.

See the flow diagram in Figure 7.2 for further scenario changes described below.

Case narrative, continued

The patient should immediately receive supportive therapy in the form of IVFs for hypotension. If such therapy is not started within 5 min the patient should prompt intervention by saying, “I’m really not feeling well.”

Any ordered labs/imaging may return after the first 5 min. By this time, the learner should consider calling the poison control center for advice concerning antivenom therapy. If this has not occurred after 5 min of supportive therapy, the patient should say, “I’m feeling lightheaded. Isn’t there something else you can give me?”

Once antivenom therapy has been initiated, clinical improvement is seen. If no therapy is started, the patient then develops pulseless wide complex tachycardia. The advanced student can then go through ACLS protocols, although no therapy other than antivenom treatment will result in clinical improvement.

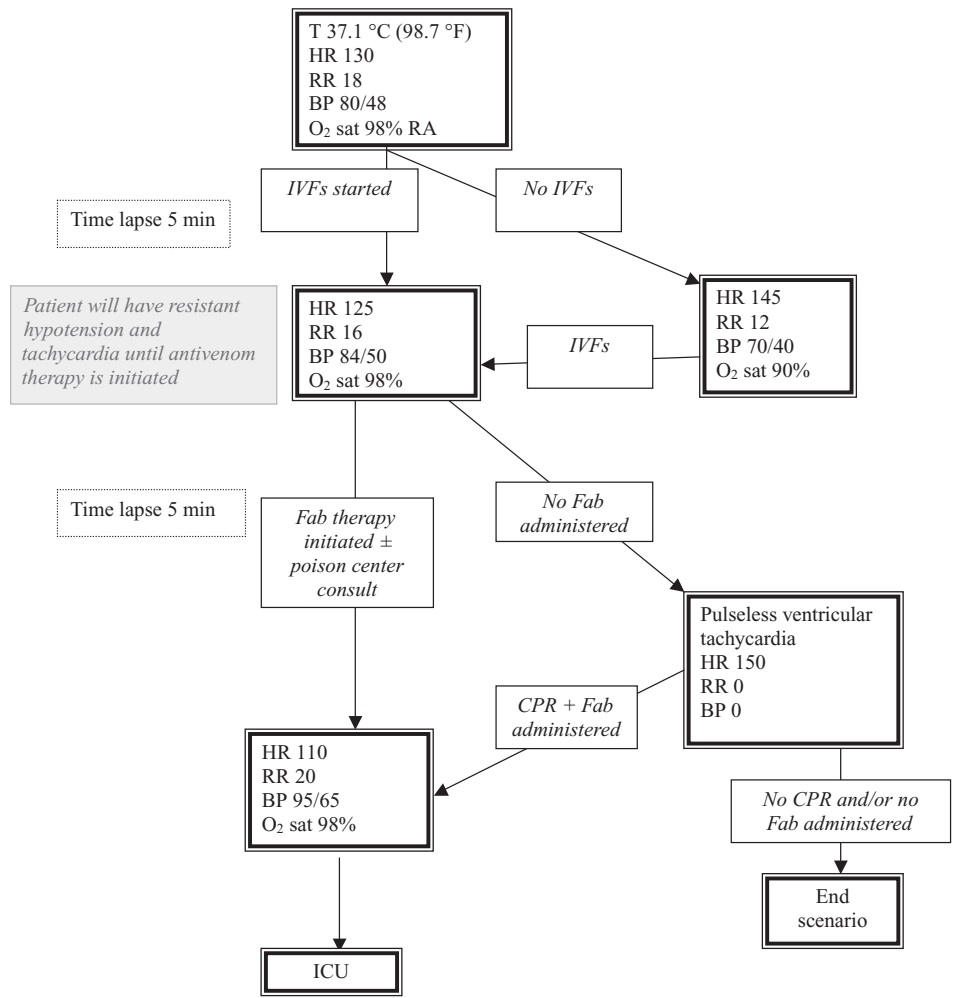


Figure 7.2 Scenario flow diagram: snake bites.

Instructor notes

Pathophysiology

Two types of snakes are clinically relevant: crotaline and elapid snakes.

Crotaline snakes (pit vipers)

- Characteristic pit seen between the eye and the nose:
 - Two fangs present.
- Secrete and inject a complex substance causing:
 - Local tissue destruction.
 - Vascular injury.
 - Hemolysis and fibrinolysis → coagulopathy.
 - Neurologic disturbances.
- Up to 20–25% of bites are dry bites with no venom secreted.
- Severity of envenomation is multifactorial:
 - Size of snake.
 - Size of patient.
 - Location of bites.
 - Number of bites.
 - Depth of bites.
 - Time from bite to presentation.

Elapid snakes (coral snakes)

- Increased vascular permeability.
- Neurotoxicity without local injury:
 - Alteration of acetylcholine function (release and binding).
- Symptoms can be delayed by up to 12 h from the time of the bite.
- The phrase *red on yellow, kill a fellow; red on black, venom lack* applies only to snakes endemic to the United States.

Clinical features

Crotaline snakes

- Obvious fang marks with surrounding tissue injury (ecchymosis common).
- Edema is seen and tends to extend from the actual bite.
- GI distress is frequent, as is perioral anesthesia.
- Patients are often tachycardiac and hypotensive.
- Altered mental status is common.
- Laboratory abnormalities:
 - Coagulopathy (PTT/PT increased).
 - Thrombocytopenia and leukocytosis.
 - Fibrinogen decreased and fibrinogen split products increased.

Elapid snakes

- GI distress is one of the earliest signs.
- Headache.

- Neurologic findings often start with ptosis and visual changes.
- Weakness frequently progresses to paralysis of peripheral and truncal muscles.
- Laboratory abnormalities:
 - Coagulopathy (PTT/PT increased).
 - Renal failure (due to muscle breakdown and myoglobinuria).
 - Urinalysis with myoglobinuria.
 - Fibrinogen decreased and fibrinogen split products increased.

Diagnosis

Crotaline snakes

- Visual evidence of snake bite.
- Tissue injury surrounding snake bite.

Elapid snakes

- High clinical suspicion as symptoms may be delayed 10–12 hours.

Management

Crotaline snakes

- Supportive therapy:
 - Update tetanus.
 - Monitor for compartment syndrome.
- Poison control center consultation.
- Bite-specific therapy:
 - Polyvalent immune Fab preferred over anti-venom:
 - Better safety profile, fewer allergic reactions.
 - Initial dose to control symptoms with maintenance doses at 6, 12, and 18 h after symptoms controlled:
 - Doses calculated by Poison Center (or, if consultation not available, standard dose is 4–6 vials immediately and then two vials every 6 h for an additional three doses)
 - Contraindicated in patients with allergy to papain or papaya extract.
- Minimum of 8 h of observation recommended; admission usually required.
- Serial laboratory studies (CBC, PT/PTT) recommended.

Elapid snakes

- Minor bites: primarily sensory changes around the site of the bite:
 - Supportive therapy.
 - Update tetanus as necessary.
- Severe bites: systemic paresthesias, cranial nerve abnormalities, vomiting, respiratory failure:
 - Supportive therapy.
 - Baseline laboratory studies:
 - CBC.
 - PT/PTT.

- Complete metabolic panel.
- Arterial blood gas (if respiratory symptoms seen).
- Pulmonary function test (if respiratory symptoms seen).
- Serial CBC, PT/PTT every 4–6 h.
- Antivenom.
- Poison Center consultation.
- Antivenom therapy:
 - Dose dependent on snake species.
 - Contraindicated in patients with allergy to horse serum.
- Admission warranted (ICU if symptomatic); all bite victims should be observed for 24 h to monitor for delayed onset of symptoms.

Debriefing Plan

Plan ~30 min for discussion.

Potential questions for discussion

- What two types of snakes are responsible for most poisonous envenomations?
- What are the clinical manifestations of crotalide envenomations and of elapid envenomations?
- How should snake bites be managed in the pre-hospital setting?
- What standard laboratory studies should be obtained in all cases of snake bite?
- What consultant should be called immediately for all snake bite cases?
- What is the definitive therapy for snake bite victims?

Selected reading

1. Weinstein S, Dart R, Staples A, White J. Envenomations: an overview of clinical toxicology for the primary care physician. *Am Fam Physician* 2009;**80**(8):793–802.
2. Warrell DA. Snake bite. *Lancet* 2010;**375**(9708):77–88.

Dive injury

Educational goals

Learning objectives

Primary:

1. Identify clinical signs of dive injury [*Medical Knowledge*].
2. Initiate appropriate treatment for common dive injuries [*Medical Knowledge, Patient Care*].

Secondary:

1. Exhibit professional interactions with ED staff and consultants [*Interpersonal and Communication Skills, Professionalism*].
2. Demonstrate ability to disposition patient appropriately [*Systems-based Practice, Medical Knowledge*].

Critical actions checklist

- ☐ Place patient on a cardiac monitor and pulse oximeter [*Patient Care*]
- ☐ Administer supplemental oxygen [*Medical Knowledge*]
- ☐ Obtain pertinent information regarding the inciting dive; include depth and type of breathing apparatus [*Medical Knowledge*]
- ☐ Consult appropriate resources or on-site hyperbaric consultant [*Medical Knowledge, Systems-Based Practice?*]
- ☐ Initiate supportive therapy (IV fluids, analgesics) [*Medical Knowledge*]
- ☐ Call and communicate to medical team for disposition [*Interpersonal and Communication Skills, Professionalism*]

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Male simulator mannequin on a stretcher. The simulator should be wearing a wet suit unzipped down to the waist. If a wetsuit is not available the mannequin should be in a bathing suit.

Bubble wrap or crisped rice cereal placed in a ziplock-type bag may be placed under the removable neck skin and inside upper chest skin of the mannequin to recreate the sound and feel of subcutaneous emphysema.

Props: To be displayed on room monitor or printed out as handouts to be provided upon request:

- Imaging (see the online component for Dive Injury, *Scenario 7.3.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG with sinus tachycardia.
 - Preliminary radiology read of chest X-ray showing pneumomediastinum and left pneumothorax.
- Labs (see online as above):
 - Complete blood count.
 - Complete metabolic panel.
 - Liver function tests.
 - Cardiac enzymes.
 - Coagulation panel.
 - Arterial blood gas.

Available in the treatment room:

- Standard airway equipment, including oxygen and masks.
- Code cart.
- Equipment for chest tube thoracostomy.
- IVF [0.9% normal saline (NS) and 5% dextrose in water (D5W)].

Distractor: None.

Actors:

- Paramedics are able to provide some information about the scene, including that the patient and his dive partner were waiting on shore. No therapy was administered prior to paramedics arriving.
- Dive partner states that the patient has completed hundreds of dives without any difficulty. Today the patient encountered a small school of sharks while 110 ft under water and got “spooked,” and ascended much more quickly than usual. They were diving for about 20 min.
- Patient voice is male. Patient should speak in short sentences with clear speech. He is having mild chest pain and feels short of breath.

- ED nurse can start IVs and also administer medications and fluids. The nurse does have some medical knowledge base and may cue learners if needed.
- Hyperbaric medicine specialist is available via telephone consultation.
- General medicine and ICU physicians are available via telephone consultation for admission.

Case narrative**Scenario background**

A 33-year-old male was found sitting on the beach, with his dive partner and two other divers. The patient states he is an experienced diver but today got spooked by a small school of sharks and ascended very rapidly. As soon as he reached the surface he noted mid-sternal chest pain and mild–moderate shortness of breath. He estimates this occurred ~30 min prior to arrival.

Background may be presented prior to case, by EMS, by dive partner, or by triage sheet.

CC: Chest pain and dyspnea after scuba diving.

PMH: Denies.

Meds: Ibuprofen as needed.

Allergies: Penicillin.

Family Hx: Non-contributory.

Social Hx: Rare alcohol, denies smoking and illicit drugs.

Initial scenario conditions

Patient is awake and mildly uncomfortable.

VS: Temp. 37.3 °C (99.1 °F), HR 108, RR 24, BP 100/68, O₂ sat 94% RA.

Heart: Regular rate and rhythm; no murmurs, rubs, or gallops.

Lungs: Absent breath sounds on the left.

Neck: Subcutaneous emphysema.

Neuro: Patient is awake and alert. Cranial nerves are intact. Strength is grossly 5/5 but the examination is somewhat limited by the patient's pain. Gait is similarly difficult to assess. Sensation is intact to light touch. Speech is clear.

See the flow diagram in Figure 7.3 for further scenario changes described below.

Case narrative, continued

The patient will initially require supplemental oxygen and a chest tube for stabilization. If both of these interventions are not performed, the patient will decompensate.

If your mannequin is not capable of simulating chest tube insertion, a thoracostomy task-trainer may be introduced for this procedure, or alternatively, you could have your learners verbally narrate the steps they would go through to place a chest tube.

Once the patient is stabilized, the learner should consult hyperbarics. If the learner does not consult hyperbarics, the patient will become confused secondary to a cerebral air embolism. This confusion can be illustrated by incoherent speech from the patient. The nurse may then prompt the learner to consult for hyperbaric therapy by asking, “Why do you think the patient is confused? What can be done to fix it?”

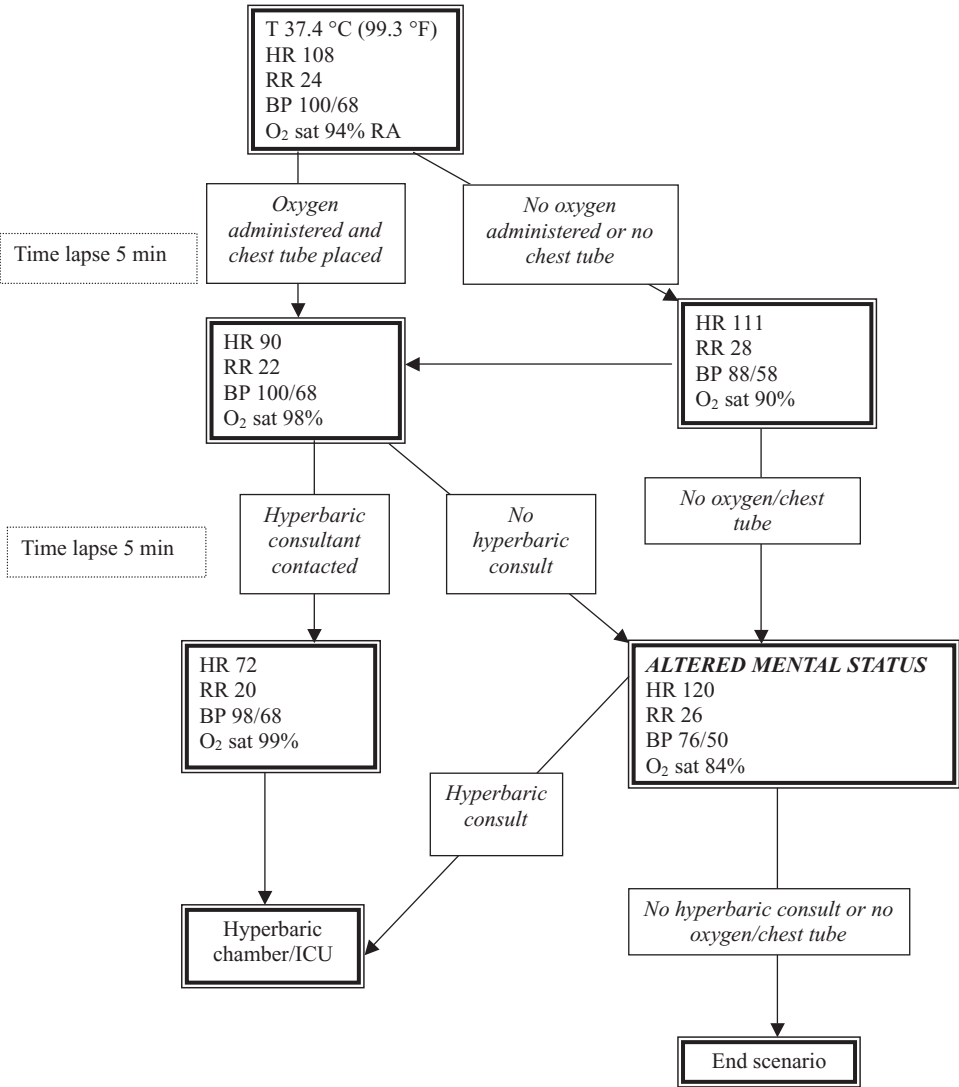


Figure 7.3 Scenario flow diagram: dive injury.

Instructor notes

Pathophysiology

- Diving injuries are based on alterations to Boyle's law: at a constant temperature, the pressure of a gas is inversely related to volume:
 - The atmosphere (atm) is the unit commonly used to describe pressure as it relates to diving injuries: 1 atm = 760 mmHg.
 - Pressure changes by 1 atm for every 33 ft of water.
 - Atmospheric pressure at the water surface must also be included in pressure calculations.
 - As pressure increases at increasing depths, volume in the lungs decreases.
- Descent-related barotrauma includes:
 - Inner ear (barotitis interna):
 - Occurs with extremely rapid descent or Valsalva movement.
 - Cochleovestibular apparatus disrupted.
 - Severe vertigo.
 - Severe tinnitus.
 - Significant hearing loss.
 - Middle ear (barotitis media):
 - Most common dive injury.
 - Pain with descent.
 - Decreased hearing.
 - \pm vertigo:
 - More common with tympanic membrane perforation and water entry through the perforation.
 - Outer ear (barotitis externa):
 - Pain, edema, hemorrhage of the external ear canal.
 - Sinus.
 - Facial compression (due to pressure changes within the diving mask):
 - Subconjunctival hemorrhage.
 - Facial fractures.
 - Orbital rupture.
- Ascent-related barotrauma includes:
 - Significant symptoms typically appear within 10–15 min of ascent; symptoms may arise up to 24 h after ascent.
 - Pulmonary.
 - Decompression illness (DCI):
 - Decompression sickness (DCS).
 - Arterial gas embolism (AGE).

Clinical features

- Ear trauma: pain due to tympanic membrane rupture and/or labyrinthine window rupture.
- Sinus trauma: epistaxis, pain, sensory alterations in the infraorbital nerve distribution.

- Facial trauma: bruising, subconjunctival hemorrhage, rare orbital hemorrhage.
- Pulmonary trauma: dyspnea, mild chest pain, subcutaneous air on anterior chest wall and neck:
 - Air can spread to the pulmonary circulation, causing cerebral air embolus (manifests as stroke-like symptoms).
- Decompression sickness:
 - Type 1:
 - Joint pain.
 - Pruritis.
 - Skin mottling.
 - Type 2:
 - Cough.
 - Dyspnea.
 - Chest pain.
 - Altered sensation.
 - Difficulty ambulating.
 - Tinnitus.
 - Altered hearing.
 - Type 3:
 - Type 2 symptoms plus arterial gas embolus.

Diagnosis

- Ear, trauma, sinus and facial trauma diagnosed on the basis of clinical suspicion and examination findings.
- Pulmonary trauma: chest X-ray.
- Decompression sickness: neurologic dysfunction.
- Laboratory studies not particularly helpful; may be needed prior to initiation of hyperbaric therapy.

Management

- Consult online resources and/or hyperbaric consultation:
 - US Navy Dive Manual: http://www.supsalv.org/00c3_publications.asp?destPage=00c3andpageID=3.9:
 - Treatment tables.
 - Prevention strategies.
 - General reference.
 - www.divetables.info.
 - Pulmonary/critical care specialists certified in hyperbaric medicine.
 - Divers Alert Network (www.diversalertnetwork.org), 1-919-684-9111.
 - Duke Dive Medicine, 1-919-684-8111.
- Ear trauma: analgesia, decongestants, otolaryngology referral for worsening hearing or vestibular symptoms.
- Sinus trauma: topical vasoconstrictors, decongestants, analgesia.

- Facial trauma: supportive therapy, analgesia. Ophthalmology consult for suspected orbital hemorrhage.
- Pulmonary trauma:
 - IVF and supplemental high-flow O₂.
 - If a pneumothorax is present, tube thoracostomy should be performed before hyperbaric oxygen therapy is initiated.
- Decompression sickness:
 - Supplemental oxygen (high-flow).
 - Type 3 necessitates hyperbaric oxygen therapy.

Debriefing plan

Plan for ~30 min for discussion.

Potential questions for discussion

- What is Boyle's law?
- Why is Boyle's law clinically relevant?
- What injuries are commonly seen with descent? How do these conditions manifest? How should these conditions be treated?
- What injuries are commonly associated with ascent? How do these conditions present? How should these conditions be treated?
- What resources are available regarding dive-related injuries?

Selected reading

1. Carson WK, Mecklenburg B. The role of radiology in dive-related disorders. *Mil Med* 2005; **170**(1):57–62.
2. Gempp E, Blatteau JE. Preconditioning methods and mechanisms for preventing decompression sickness in scuba divers: a review. *Res Sports Med* 2010; **18**(3):205–218.
3. Vann RD, Butler FK, Mitchell SJ, Moon RE. Decompression illness. *Lancet* 2010; **377**:153–164.

CHAPTER 8 **Obstetric emergencies**

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Eclampsia

Educational goals

Learning objectives

Primary:

1. Recognize eclampsia as cause of seizure in late pregnancy [*Medical Knowledge*].
2. Demonstrate appropriate resuscitation and management of eclampsia [*Patient Care*].

Secondary:

1. Describe appropriate medication choices for seizure and blood pressure control in eclampsia [*Medical Knowledge*].
2. Demonstrate clear communication with an obstetric (OB) consulting service [*Systems-based Practice, Interpersonal and Communication Skills*].

Critical actions checklist

- ☐ Assess and manage airway, breathing, and circulation (ABCs), including performance of rapid sequence intubation (RSI) [*Patient Care*]
- ☐ Obtain fingerstick glucose test [*Medical Knowledge*]
- ☐ Give magnesium sulfate (MgSO_4) IV [*Medical Knowledge, Patient Care*]
- ☐ Initiate blood pressure control (hydralazine or labetalol) [*Patient Care*]
- ☐ Look for signs of fetal distress on ultrasound (US) or fetal monitor [*Patient Care, Medical Knowledge*]
- ☐ Provide clear communication to OB of diagnosis and the need for emergent delivery [*Systems-based Practice, Interpersonal and Communication Skills*]

Critical actions can be changed to address the educational needs of the learner. For example: a medical student might not be expected to obtain and interpret bedside ultrasound images, but that expectation would be reasonable for a senior postgraduate learner.

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin, moulded to reflect a woman of reproductive age in late pregnancy, on a stretcher or hospital bed. Mannequin will initially be actively seizing.

Pregnancy can be simulated by placing a pillow or blanket under clothes or by using a commercial pregnancy simulator such as The Empathy Belly (Birthright, Inc., Vashon, WA). If your mannequin does not have the functionality to simulate a seizure, ask a nurse to say that the patient is seizing and to shake the mannequin or the stretcher/bed to simulate a seizure.

Props: To be displayed on plasma screen/computer screen or printed on handouts that are distributed when the participants ask for laboratory results:

- Images (see the online component for Eclampsia, *Scenario 8.1.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - Fetal heart rate (FHR) monitoring revealing no abnormalities at 150 beats/min.
 - Radiology report of bedside ultrasound with FHR of 150 beats/min, a full-term fetus with head down, good fetal movement.
 - Radiology report of normal computed tomography (CT) scan of the head.
 - Chest X-ray.
- Labs (see online component as above):
 - Complete blood count (CBC).
 - Basic metabolic panel.
 - Lactate.
 - Coagulation panel.
 - Liver function tests (LFTs).
 - Urinalysis (UA).
 - Urine pregnancy test.

Available in the treatment room:

- Basic airway and code cart.
- Intravenous fluid: normal saline.
- FHR monitor simulator (if available).
- Ultrasound machine and/or fetal Doppler (if available).
- Medications:
 - Sedative and paralytics for RSI (e.g. etomidate, succinylcholine).
 - MgSO₄.
 - Hydralazine.
 - Labetalol.

Distractor: None.

Actors:

- Paramedics who are able to provide information about the patient.
- No patient voice is needed, because the mannequin is seizing and requires intubation.
- The ED nurse can establish IV lines and administer medications/fluids. The nurse can cue learners as needed. Depending on the fidelity of the mannequin, the nurse may need to clarify whether or not the patient is seizing ("It looks like she is still seizing," or "The seizure seems to have stopped.>").
- The OB physician is initially unavailable because he is attending a delivery, but the unit secretary offers to take a message for him.

Altering the availability of the consulting service is a good way to increase or decrease scenario difficulty. For example, OB can be available immediately to guide and prompt a junior learner. For an advanced participant, making consultants initially unavailable requires the learner to direct patient management.

Case narrative

Scenario background

A 19-year-old female having tonic–clonic seizure activity was found by her room-mate. The room-mate called 911. On arrival, the responding EMS personnel placed an 18-gauge IV line. They gave no medications and performed no other interventions. When the ambulance arrived at the ED, the patient was actively seizing. The room-mate told the pre-hospital care providers that the patient is pregnant. Her due date is 3 weeks away. No other history is known.

Background may be presented by EMS personnel or the room-mate or distributed as a triage sheet.

CC: Seizure.

PMH: Unknown.

Meds: Unknown.

Allergies: Unknown.

Family Hx: Unknown.

Social Hx: Unknown.

Initial scenario conditions

The patient is actively seizing, with full-body tonic–clonic seizures, and is unresponsive.

If your mannequin does not have seizure functionality, a seizure can be simulated by having someone shake the mannequin.

VS: Temp. 37.0 °C (98.6 °F), BP 184/114, HR 95, RR 20, O₂ sat 96%, FHR 150.

Eyes: No deviation of eyes; pupils are equal and reactive to light.

Heart: Mild tachycardia, no murmurs.

Lungs: Equal sounds bilaterally, clear to auscultation.

Abdomen: Soft, gravid uterus with fundus near xyphoid.

Pelvic examination: Closed cervical os, no gross blood.

Neuro: Eyes closed; no verbal response; no motor response; tonic–clonic seizure activity.

Physical examination findings that are not available on your mannequin can be reported verbally if the learners request them. If incorrect findings are stated (e.g. “The pupils are dilated.”), the nurse in the room should state the correct findings (e.g. “The pupils look equal and reactive bilaterally to me.”).

See the flow diagram in Figure 8.1 for further scenario changes described below.

Case narrative, continued

The seizure activity will continue until the patient is given appropriate doses of MgSO_4 . If the airway is not managed and ventilatory support is not given, the oxygen saturation will drop. If the patient is paralyzed for intubation, the seizure will stop temporarily (depending on the duration of the paralytic used). Once the seizure has been controlled with MgSO_4 , it will not restart, but the patient will remain unresponsive.

The blood pressure will remain elevated even if magnesium is given. It will improve with appropriate doses of antihypertensive medications. After the seizure has been controlled, the learner should order and/or start FHR monitoring and contact OB.

Depending on the level of the learner, OB can be available and helpful, unavailable, or push the learner to transfer the patient to a medical center better equipped to manage eclampsia and a premature infant.

FHR tracings will remain at a normal rate with good variability (reassuring). If the participant has not checked the heart rate, the OB consultant can ask, “How is the baby doing?” The nurse can then prompt the reading and/or show the FHR monitor of 150 beats/min. After appropriate communication, the case can end with the patient being transferred to a tertiary care center or admitted to the hospital’s OB service.

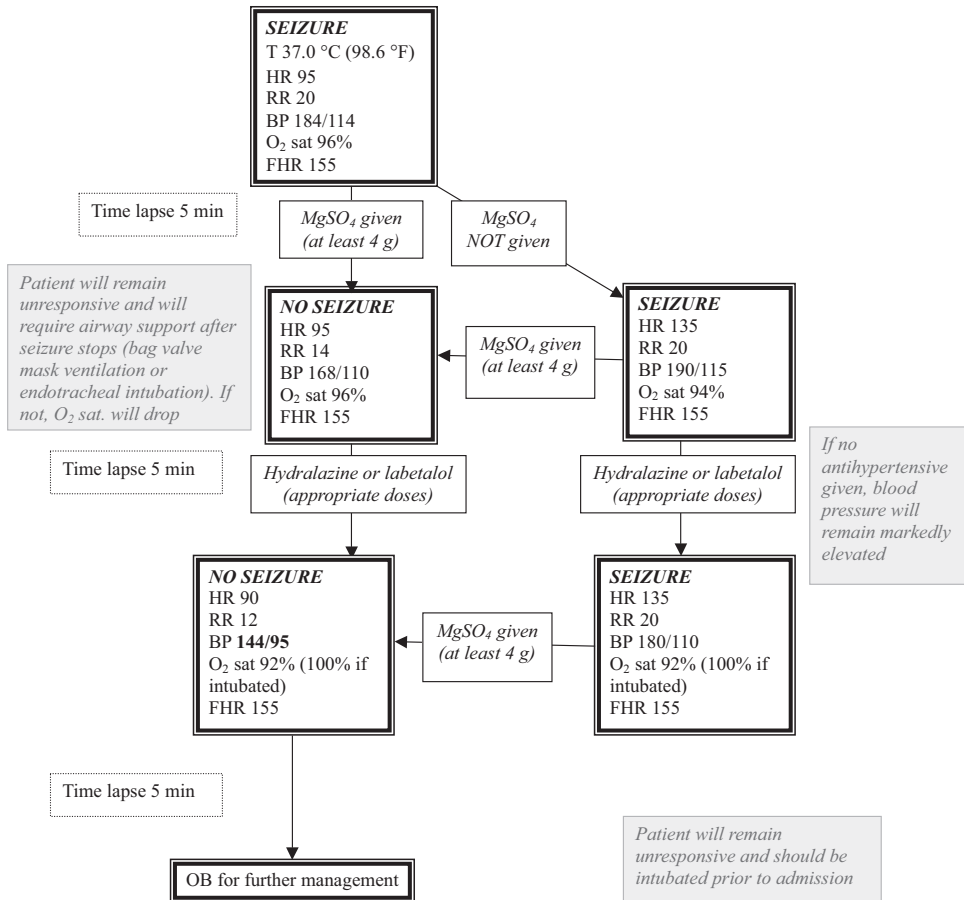


Figure 8.1 Scenario flow diagram: eclampsia.

Instructor notes**Background**

- Eclampsia is defined as an unexplained seizure or altered mental status in a woman with pre-eclampsia.
- Affects 1/2000–1/3500 pregnancies.
- The associated maternal mortality rate is around 2%, with fetal mortality as high as 30% (primarily due to prematurity).

Pathophysiology

- Thought to be secondary to hypertensive encephalopathy, vasogenic cerebral edema with ischemia, or hemorrhage.
- The exact mechanism is unknown.

Clinical features

- Seizure or postictal state.
- Pre-eclampsia:
 - Hypertension.
 - Headache (80%).
 - Edema (50%).
 - Visual changes (40%).
 - GI: right upper quadrant abdominal pain, nausea (20%).
- Can occur antepartum, intrapartum, or postpartum; 90% occur at >28 weeks' gestation.

Diagnosis

- Hypertension (>140 mmHg systolic or >90 mmHg diastolic).
- Proteinuria (>300 mg/24 h or >1 g/L).
- Head CT scan to rule out other causes.
- Laboratory studies:
 - HELLP syndrome is a severe form of pre-eclampsia:
 - Hemolytic anemia.
 - Elevated liver function tests.
 - Low platelet count.
 - Rule out other causes (hypoglycemia, hyponatremia).

Management

- Seizure control:
 - Magnesium sulfate:
 - Superior to phenytoin.
 - Dosing:
 - 4 g bolus, repeated until seizure stops.
 - Then, infusion of 1–3 g/h for 24 h.
 - Benzodiazepines are second-line agent.

- Blood pressure control:
 - Generally recommended for systolic >160 mmHg and diastolic >105 mmHg.
 - Goal is blood pressure of 140–160/90–105 (avoid too great a correction because it can lead to inadequate uteroplacental perfusion).
 - Hydralazine is considered first-line agent:
 - 10–20 mg IV bolus:
 - Repeat if no response in 20 min.
 - Consider alternative medication if no response after three doses.
 - Labetalol:
 - 20 mg IV bolus:
 - If no response, give 40 mg after 10 min.
 - If still no response, can give 80 mg 10 min apart, to a maximum total dose of 220 mg.
 - Nitroprusside:
 - Not recommended because fetal cyanide toxicity can occur.
- Delivery of the fetus is considered definitive care (unless postpartum):
 - Must be weighed against fetal risk if pre-term.
 - Vaginal delivery is preferred but cesarean section may be required if maternal condition worsens or signs of fetal distress emerge, such as:
 - FHR <100 or >160 beats/min.
 - Absent beat-to-beat variability.
 - Late decelerations.
- Consider transfer to a high-risk obstetric facility with maternal and neonatal intensive care.

Debriefing plan

Allow ~30 min for discussion.

Potential questions for discussion

- What is the first-line medication to treat eclampsia and what is the dose?
- What are the side effects of MgSO_4 ?
- During what portion of pregnancy does eclampsia typically occur?
- What is the definitive treatment for eclampsia?
- What parameters should be used for blood pressure control in eclampsia?
- What laboratory abnormalities can be associated with severe pre-eclampsia?
- What is the role of bedside ultrasound and fetal monitoring in eclampsia?

Selected reading

1. Guy AM, Silverberg MA. Pregnancy, eclampsia. *eMedicine* updated August 11, 2009.
2. Stead LG. Seizures in pregnancy/eclampsia. *Emerg Med Clin North Am* 2011;**29**:109–16.

Ruptured ectopic pregnancy

Educational goals

Learning objectives

Primary:

1. Identify clinical signs of ectopic pregnancy [*Medical Knowledge*].
2. Demonstrate appropriate resuscitation and management of ruptured ectopic pregnancy [*Patient Care*].

Secondary:

1. Demonstrate professionalism and empathy in communication with patient [*Interpersonal and Communication Skills, Professionalism*].
2. Describe proper disposition and obtain appropriate consultation [*Systems-based Practice*].

Critical actions checklist

- ☐ Address hypotension with aggressive fluid resuscitation [*Patient Care*]
- ☐ Obtain pregnancy test and type and screen [*Medical Knowledge*]
- ☐ Perform bedside ultrasound [*Patient Care*]
- ☐ Administer O-negative blood [*Patient Care, Medical Knowledge*]
- ☐ Discuss plan with patient, including need for blood transfusion and surgery [*Interpersonal and Communication Skills, Professionalism*]
- ☐ Call and communicate to obstetrics (OB) the need for operative intervention [*Systems-based Practice, Interpersonal and Communication Skills, Professionalism*]

Critical actions can be changed to address the educational needs of the learner. For example, a medical student might not be expected to obtain and interpret bedside ultrasound images, but that expectation would be reasonable for a senior postgraduate learner.

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin, mouldaged to reflect a female of reproductive age, on a stretcher or hospital bed.

A standardized patient actor could play the role of the patient, using mannequin monitor data to reflect hemodynamic instability.

Props: To be displayed on plasma screen/computer screen or printed on handouts that are distributed when the participant asks for laboratory results

- Images (see the online component for Ruptured Ectopic Pregnancy, *Scenario 8.2.ppt*, at www.wiley.com/go/thoureen/simulation/workbook, and Videoclip 8.2):
 - Abdominal and chest X-ray films that are normal.
 - Bedside Focused Abdominal Sonogram for Trauma (FAST), revealing intra-abdominal fluid. Left upper quadrant view (Video clip 8.2a), right upper quadrant view (Video clip 8.2b), and suprapubic view (Video clip 8.2c) are embedded in the online component mentioned above.
- Labs (see online component as above):
 - Complete blood count (CBC).
 - Basic metabolic panel (BMP).
 - Lactate.
 - Coagulation panel.
 - Amylase/lipase.
 - Liver function tests (LFTs).
 - Urinalysis.
 - Pregnancy test: qualitative (urine) and quantitative (serum).
 - Blood type.

Available in the treatment room:

- Basic airway and code cart.
- Intravenous fluid (normal saline).
- Labeled bags of O-negative blood.
- Ultrasound machine (if available).

Distractor: None.

Actors:

- Patient voice is female. If the learners do not consider pregnancy, the patient can prompt with questions such as, "Am I pregnant?" Alternatively, the patient may be played by a standardized patient.

Having an unstable patient played by a human actor is a good way to increase the realism of the case and prevent learners from being trained that standardized patients are always healthy and mannequins are always sick.

- The ED nurse can start IV fluids and administer medications. The nurse can cue learners as needed.
- An OB physician is available by telephone. You can increase the difficulty of the case for advanced learners by making OB consultation initially unavailable.

Case narrative

Scenario background

A 30-year-old woman comes to the ED with abdominal pain of sudden onset, which began after intercourse. The pain is 10 out of 10 and located throughout the entire abdomen. If the participant is asked if she is pregnant, she says she is trying to conceive but does not think she is pregnant. Her last period was 2 weeks ago and was heavier and earlier than expected.

Background may be presented by the patient or distributed as a triage sheet.

CC: Abdominal pain.

PMH: Depression, one previous pregnancy that ended with miscarriage.

Meds: Citalopram.

Allergies: None.

Family Hx: Unremarkable.

Social Hx: Smoker, occasional alcohol, history of polysubstance abuse.

Initial scenario conditions

Patient is in obvious discomfort, moaning in pain but cooperative.

VS: Temp. 36.6 °C (97.8 °F), BP 118/67, HR 72, RR 20, O₂ sat 100% RA.

Eyes: Pupils are equal and reactive bilaterally; conjunctivae are normal.

Heart: Normal rate and rhythm, no murmurs.

Lungs: Equal sounds bilaterally, clear to auscultation.

Abdomen: Rigid and diffusely tender with no obvious areas of focal tenderness.

Pelvic examination: Examination is refused by patient due to pain.

The patient or nurse can verbally report physical examination findings that are not available on your mannequin, if information is requested by learners.

See the flow diagram in Figure 8.2 for further scenario changes described below.

Case narrative, continued

Her pain continues to be severe and does not lessen with pain medications. Within 2 min after arrival, the patient's heart rate increases and her blood pressure drops. The learner should establish IV access and run fluids "wide open." During this time, laboratory studies should be obtained and bedside ultrasound can be performed. The instructor may state that no intrauterine pregnancy is identified if specifically asked by learner. If inadequate fluids are given, the patient becomes less responsive, more tachycardic, and hypotensive.

Even if IV fluids are given appropriately, the patient becomes more tachycardic and hypotensive over the next 5 min. This should prompt the learner to give O-negative blood, but the patient's condition stabilizes only temporarily. This should prompt an emergent call to OB for surgical intervention.

If vasopressors are given, they will not significantly improve the blood pressure.

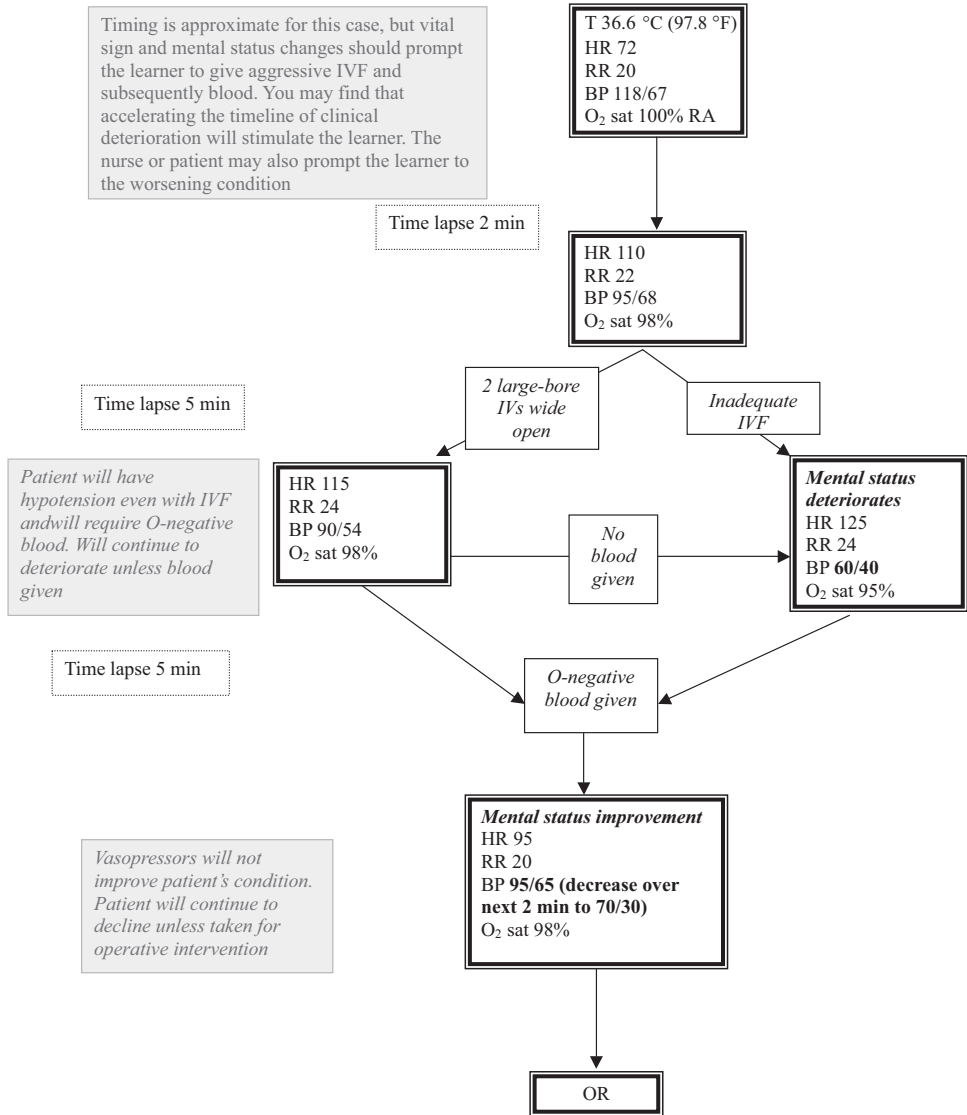


Figure 8.2 Scenario flow diagram: ectopic pregnancy.

Instructor notes

Background

- Ectopic pregnancy is defined as any pregnancy that occurs outside the uterus.
- Most common sites of ectopic pregnancy:
 - Female reproductive tract ("tubal pregnancy") (98%).
 - Abdominal cavity, ovary, cervix (rare).

Pathophysiology

- Growth of the ectopic pregnancy irritates surrounding tissue.
- Rupture may lead to hypotension and peritoneal irritation.

Clinical features

- Abdominal pain and vaginal bleeding are the most common symptoms.
- Triad of abdominal pain, delayed menses, and vaginal bleeding is not reliably present.
- Hypotension from hemorrhagic shock.

Diagnosis

- A negative pregnancy test essentially rules out this diagnosis.
- A positive pregnancy test requires ultrasound (US):
 - Intrauterine pregnancy (IUP) seen on US rules out ectopic pregnancy, except in rare cases of heterotopic pregnancy:
 - Heterotopic pregnancy is an IUP *and* an ectopic pregnancy:
 - Rare (1/2600 pregnancies).
 - Increased risk with fertility treatment.
 - Ectopic pregnancy seen on US is diagnostic.
 - No IUP, no ectopic seen on US:
 - Ectopic should be assumed until proven otherwise.
 - Discriminatory threshold is the level of quantitative β -human chorionic gonadotropin hormone (β -hCG) at which a US would be expected to show an IUP:
 - β -hCG ≥ 1500 mIU/mL (transvaginal US).
 - Ectopic pregnancy is twice as likely if β -hCG < 1500 mIU/mL.
- Abdominal pain and hypotension in a reproductive-age female are suggestive of ruptured ectopic pregnancy.

Management

- Treatment of hemorrhagic shock:
 - IVF: wide open via two large-bore IV lines.
 - Blood products:
 - Should be administered if the patient remains unstable despite 2–4 L of crystalloid fluid.
 - Type and cross of at least 2 units of packed red blood cells.
 - Administer O-negative blood if delivery of cross-matched blood is delayed.

- Specific treatment of ectopic pregnancy:
 - Medical:
 - Methotrexate
 - Consider only if:
 - Patient is stable.
 - No active bleeding or hemoperitoneum.
 - Unruptured ectopic <3.5 cm in size.
 - β -hCG <15 000 mIU/mL.
 - Surgical:
 - Emergent surgery is indicated for unstable patients.
 - Surgery is urgent if the patient is stable.

Debriefing plan

Allow ~30 min for discussion.

Potential questions for discussion

- What is the role of bedside US in the evaluation of an ectopic pregnancy?
- How should one proceed if the pregnancy test is positive but the US image is equivocal?
- What are the indications for medical management of a woman with an ectopic pregnancy?
- When should blood products be given to a patient with hemorrhagic shock?
- What are the expected clinical findings of ectopic pregnancy?
- Do vasopressors have a role in hemorrhagic shock?
- What role does the β -hCG discriminatory threshold play in the workup of ectopic pregnancy?

Selected reading

1. Promes SB, Nabay F. Pitfalls in first-trimester bleeding. *Emerg Med Clin North Am* 2010;**28**:219–234.
2. Mukul LV, Teal SB. Current management of ectopic pregnancy. *Obstet Gynecol Clin North Am* 2007;**34**:403–419.

Trauma in pregnancy

Educational goals

Learning objectives

Primary:

1. Recognize placental abruption as a cause of third-trimester abdominal pain [*Medical Knowledge*].
2. Appropriately diagnose placental abruption and recognize fetal heart rate (FHR) tracing that warrants concern [*Patient Care*].
3. Identify and initiate appropriate treatment with obstetrics (OB) consult for emergent delivery [*Systems-based Practice, Interpersonal and Communication Skills, Patient Care*].

Secondary:

1. Recall limitations of ultrasound (US) for ruling out placental abruption [*Medical Knowledge*].
2. Identify whether your state mandates reporting of suspected domestic abuse [*Systems-based Practice*].

Critical actions checklist

- ☐ Completion of primary and secondary trauma survey [*Patient Care*]
- ☐ Place patient on continuous fetal monitoring and identify non-reassuring FHR tracing [*Patient Care, Medical Knowledge*]
- ☐ Tilt patient to left side to treat hypotension (moves the uterus off the inferior vena cava) [*Medical Knowledge, Patient Care*]
- ☐ Identify and probe for issues of domestic abuse [*Interpersonal and Communication Skills, Patient Care*]
- ☐ Diagnose placental abruption [*Medical Knowledge, Patient Care*]
- ☐ Provide clear communication of the diagnosis to obstetrics and convey the need for emergent delivery [*Systems-based Practice, Interpersonal and Communication Skills*]

Critical actions can be changed to address the educational needs of the learner. For example, a medical student might not be expected to obtain and interpret continuous fetal monitoring, but this expectation is reasonable for a senior postgraduate learner.

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin moulded to reflect a woman of reproductive age in late pregnancy, lying flat on a stretcher or hospital bed. A small to moderate amount of blood is on the sheet by her vagina. Mild bruising is present on her left flank.

A gravid abdomen can be simulated with placement of a pillow or blanket under clothes or by use of a commercial pregnancy simulator such as The Empathy Belly (Birthright, Inc., Vashon, WA). A standardized patient could also play the role of the patient, using mannequin monitor data to reflect hemodynamic status.

Props: To be displayed on a plasma screen/computer screen or printed on handouts for distribution when the participant asks for laboratory results:

- Images (see the online component for Trauma in Pregnancy, *Scenario 8.3.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - FHR monitoring revealing early decelerations (Fetal Heart Monitoring 1).
 - FHR monitoring revealing late decelerations (Fetal Heart Monitoring 2).
 - Normal chest x-ray film.
 - Radiology report for normal cervical spine series, kidney, ureters, and bladder (KUB) x-ray film, and CT abdomen/pelvis.
 - Pelvic ultrasound report.
- Labs (see online component as above):
 - Complete blood count (CBC).
 - Basic metabolic panel (BMP).
 - Coagulation tests.
 - Pregnancy test: qualitative(urine) and quantitative(serum).
 - Blood type and Rh.
 - D-Dimer/fibrinogen/fibrin split products.
 - Lactate.
 - Liver function tests (LFTs).
 - Urinalysis (UA).

Available in the treatment room:

- Basic airway and code cart.
- Intravenous fluid: normal saline.
- FHR monitor simulator (if available).

Distractor: None or an optional significant other. His presence could add significant challenges to the scenario and an added critical action could be to get him out of the room so that the learner can obtain a history from the patient alone.

Actors:

- A paramedic who can provide some history (not required if someone is not available to play this role).

- Patient voice is female.
- An ED nurse can start IV lines and administer medications. The nurse can cue learners as needed.
- The obstetrician is initially unavailable because he is attending a delivery, but the unit secretary offers to take a message for him.

Altering the availability of the consulting service is a good way to increase or decrease scenario difficulty. For example, OB can be available immediately to provide guidance and prompting for a junior learner. For an advanced learner, making consultants initially unavailable requires the learner to direct patient management.

Case narrative

Scenario background

A 33-year-old pregnant woman presents with abdominal pain. She reports that she fell down a flight of stairs, offering that she is clumsy and must have slipped. (Actually, the father of the baby pushed the woman down the stairs during an argument, but she will not offer this information unless asked specifically and with empathy.) The patient declines offers of assistance in finding space at a women's shelter, no matter how the help is presented to her.

Background may be presented by the patient or an EMS care provider or distributed as a triage sheet.

CC: Abdominal pain.

PMH: Fourth pregnancy, two living children, one previous abortion; currently 38 weeks pregnant.

Meds: Prenatal vitamins.

Allergies: None.

Family Hx: Non-contributory.

Social Hx: Smoker (cut down for pregnancy), denies alcohol and drug use.

Initial scenario conditions

The patient is in moderate discomfort but no obvious distress.

VS: Temp. 36.4 °C, BP 95/64, HR 105, RR 18, O₂ sat 100%, FHR 145.

Eyes: Pupils are equal and reactive; periorbital ecchymosis on right.

Neck: No midline cervical spine tenderness to palpation.

Heart: Tachycardia, regular rhythm, no murmurs.

Lungs: Equal sounds bilaterally, clear to auscultation.

Back: No midline tenderness to palpation over the thoracic or lumbar spine.

Abdomen: Soft, gravid uterus with fundus near xyphoid; mild bruising on left flank; tenderness to palpation diffusely over abdomen, especially over uterine fundus.

Pelvis: Stable.

Genitourinary: Small to moderate amount of blood on sheets near vagina.

Pelvic examination (verbally report findings to learner if they request to perform pelvic examination): moderate amount of blood in vaginal vault; oozing blood from cervical os; mild bilateral adnexal tenderness to palpation; moderate to severe fundal tenderness to palpation; diffuse pain on bimanual examination; otherwise negative.

Rectal: Normal tone, blood on glove [source (rectal or vaginal) is not clear].

Neurologic: No focal deficits.

Extremities: No gross deformity.

Physical examination findings that are not available on your mannequin can be reported verbally if requested by learners.

See the flow diagram in Figure 8.3 for further scenario changes described below.

Case narrative, continued

The patient is slightly hypotensive and tachycardic on arrival. Her blood pressure and heart rate move towards normal if she is repositioned by being tilted towards her left side. FHR tracings should be obtained and initially reveal contractions with some early decelerations, but the heart rate remains reassuring. Bedside US (verbal report) may be stated here if the learner asked for an US, stating no intra-abdominal fluid, normal fetal movement, and FHR of 145 beats/min.

Approximately 10 min into the case, the FHR tracing shows late decelerations, and becomes non-reassuring, increasing concern. At this point, the obstetrician should be called for an emergent delivery. If the obstetrician is not informed of the need for emergent delivery, the FHR tracings deteriorate, with continued late decelerations and fetal bradycardia. If continuous FHR simulator is not available, would have the nurse state that the tracing is changing and display FHR tracing 2 and cue that the fetal heart rate seems to be slowing.

The patient progresses to tachycardia and hypotension if she is not taken to the operating room for a cesarean section.

Throughout the case, the patient's pain can be partially, but not completely, relieved by pain medications.

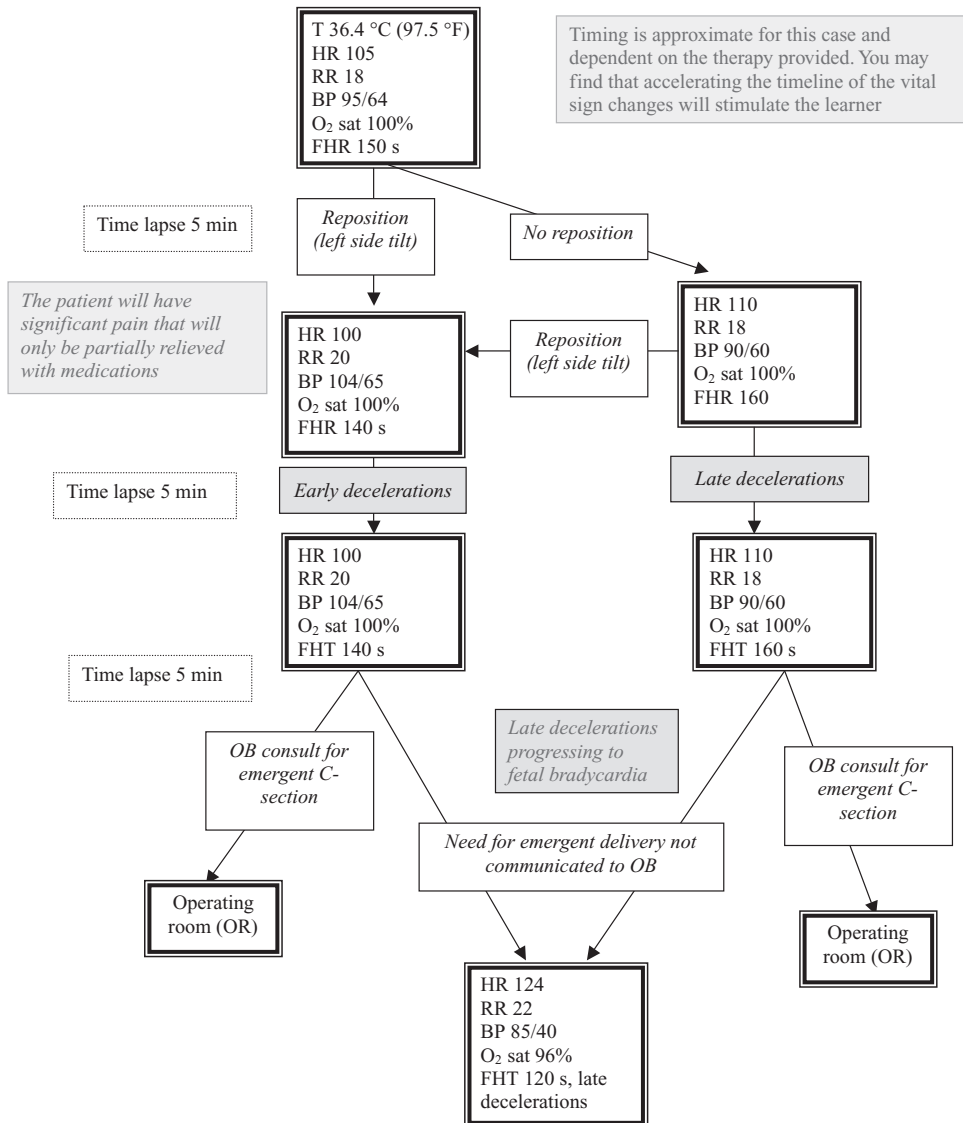


Figure 8.3 Scenario flow diagram: trauma in pregnancy.

Instructor notes**Background**

- Trauma is estimated to affect 5% of pregnancies.
- Placental abruption (also called abruptio placentae):
 - Most common cause of serious vaginal bleeding in late pregnancy.
 - Affects 1% of all pregnancies.
 - Half occur after <36 weeks' gestation.
 - Neonatal death results in 10–30% of cases:
 - 50% of deaths are related to prematurity.
 - Majority of other deaths are secondary to intrauterine asphyxia.
- Risk factors for placental abruption:
 - Tobacco and stimulant abuse (cocaine, methamphetamines).
 - Chronic hypertension.
 - Pre-eclampsia.
 - Thrombophilia.
 - Abdominal trauma.
 - Prior abruption.

Pathophysiology

- Placental abruption results when the placenta separates from the uterine wall before delivery.

Clinical features

- Vaginal bleeding:
 - Bright, dark, or mixed with amniotic fluid.
 - Bleeding may also be concealed (10–20% of cases).
- Uterine tenderness or back pain.
- Evidence of fetal distress on FHR tracing.
- Disseminated intravascular coagulation (DIC) may occur.

Diagnosis

- Often must be based on clinical history and examination findings.
- Ultrasound:
 - Not reliable for diagnosis of or excluding abruption.
 - Do not delay definitive care while awaiting US confirmation.
- Continuous fetal monitoring:
 - Should be initiated early.
 - Allows assessment of fetal well-being.

Management

- Stabilize and provide supportive care of the mother.
- Consider tilting the mother to the left if she is hypotensive (supine hypotension syndrome from uterine compression on inferior vena cava).

- Non-reassuring FHR tracing mandates emergent delivery:
 - Examples of non-reassuring findings:
 - Sustained fetal bradycardia or tachycardia.
 - Loss of beat-to-beat variability.
 - Late decelerations.
 - Cesarean section is generally preferred over vaginal delivery.
 - Decreased decision-to-delivery interval (<20 min) seems to improve neonatal outcomes.
- If fetal monitoring is reassuring and the fetus is not near term, consider glucocorticoids and observation.

Debriefing plan

Allow ~30 min for discussion.

Potential questions for discussion

- What are some unique concerns of trauma in pregnancy?
- How can the supine position affect blood pressure late in pregnancy?
- Besides trauma, what are other causes of vaginal bleeding during late pregnancy?
- Are you required to report suspected domestic abuse in your state?
- What is the role of US in evaluating for placental abruption?
- What is the role of CT scanning in pregnant patients? What are the risks and when should it be done?
- Does this patient require Rho(D) immune globulin?
- When do patients require emergent delivery in placental abruption?

Selected reading

1. Sakornbut E, Leeman L, Fontaine P. Late pregnancy bleeding. *Am Fam Physician* 2007;**75**:1199–1206.
2. Oyelese Y, Ananth CV. Management and outcome of pregnancies complicated by placental abruption. *UpToDate*; 18.3. Last updated September 24, 2010.
3. Muench MV, Canterino JC. Trauma in pregnancy. *Obstet Gynecol Clin North Am* 2007;**34**:555–583.

CHAPTER 9 Pulmonary/critical care emergencies

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Status asthmaticus

Educational goal

Learning objectives

Primary:

1. Recognize the clinical signs of an asthma exacerbation [*Medical Knowledge*].
2. Know the appropriate medical treatments for an acute asthma exacerbation [*Medical Knowledge*].
3. Recognize respiratory failure and need for invasive ventilation in status asthmaticus [*Medical Knowledge*].
4. Know and apply the correct ventilator settings for an acute asthma exacerbation (optional for senior postgraduate learners) [*Medical Knowledge, Patient Care*].

Secondary:

1. Demonstrate professionalism and communication skills in consulting the intensivist, working with the ED nurse, and interacting with the patient's family [*Interpersonal and Communication Skills, Professionalism*].
2. Direct proper disposition/appropriate consultation [*Systems-based Practice*].

Critical actions checklist

- ☐ Assess airway, breathing, circulation (ABCs) [*Patient Care*]
- ☐ Auscultate lungs and recognize wheezing as a sign of acute asthma exacerbation [*Medical Knowledge, Patient Care*]
- ☐ Provide adequate supplemental oxygen titrating to an O₂ sat between 92 and 95% [*Medical Knowledge, Patient Care*]
- ☐ Initiate appropriate therapy including a nebulized β_2 -agonist (albuterol), nebulized anticholinergic agent (ipratropium), corticosteroids, and epinephrine [*Medical Knowledge, Patient Care*]
- ☐ Recognize respiratory failure and initiate rapid sequence intubation (RSI). The largest possible endotracheal tube (ETT) should be used; minimum 7–7.5 mm for females, 7.5–8.0 mm for males [*Medical Knowledge, Patient Care*]
- ☐ Call and communicate to Intensive Care Unit (ICU) for disposition [*Patient Care, Interpersonal and Communication Skills, Professionalism*]

Emergency Medicine Simulation Workbook: A Tool for Bringing the Curriculum to Life, First Edition. Edited by Traci L. Thoureen and Sara B. Scott.

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Critical actions can be changed to address the educational needs of the learner. For example, a resident preparing for oral boards may have more specific critical actions oriented towards oral board review (i.e. check allergies before giving medications, interact with patient and family, etc.).

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin already on stretcher in hospital gown, male setup.

Props: To be displayed on plasma screen/computer screen or printed out on handouts in the scenario room when asked for/return from laboratory:

- Images (see online component for Status Asthmaticus, *Scenario 9.1.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG with sinus tachycardia.
 - Anteroposterior chest X-ray that shows hyperinflation, no infiltrates.
 - Anteroposterior chest X-ray after intubation showing good ETT position.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.

Available in the treatment room:

- Basic airway and code cart.
- Nebulizer mask.
- Medications:
 - Albuterol nebulizer solution.
 - Ipratropium nebulizer solution.
 - Corticosteroid-labeled IV bag.
 - Epinephrine prelabeled syringe.
 - Normal saline (NS) in labeled liter bags.
 - RSI medications prelabeled in syringes (paralytic and induction medication of choice for your institution).

Distractor: Optional. The wife may be very distressed, interrupting patient care. This option may be used for more experienced learners or to direct the learning for professionalism and communication evaluation.

Actors:

- Paramedics are able to provide information about patient status on arrival and medications administered already.
- Wife who may optionally act as a distractor. She is able to provide patient's medical history and the history of present illness.
- Patient voice is male. Patient should be breathless, only able to get out one word at a time, but becomes lethargic as the case progresses if appropriate medication is not given.
- ED nurse can start IVs and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed.
- ICU physician can be available via "phone consultation."
- Respiratory therapist can be available for Phase II ventilator management section, if requested.

Case narrative

Scenario background

A 35-year-old male complains of shortness of breath for 2 days, with progressive worsening, which was not resolved with nebulizer treatments at home. The patient has a history of severe asthma with prior intubation 1 year ago. His last hospitalization was 1 month prior, and he last required steroids 2 weeks ago.

EMS or the patient's wife may present the background prior to the case, or it can be given as a triage sheet, depending on the level of difficulty of the case.

CC: Shortness of breath.

PMH: Asthma.

Meds: Albuterol, fluticasone/salmeterol, montelukast.

Allergies: None.

Social Hx: No smoking, occasional alcohol, no illicit drugs.

Initial scenario conditions

The patient is a young male in respiratory distress with retractions and tachypnea. The patient's wife can be anxious, yelling for some help at the bedside.

VS: Temp. 36.6 °C (98 °F), HR 111, RR 34, BP 145/90, O₂ sat 88% RA.

General: Distressed, seated upright on the stretcher/bed.

Heart: Tachycardia, no murmurs.

Lungs: Diffuse bilateral wheezes, tachypnea, using accessory muscles.

Extremities: No edema.

Physical examination findings not available on your mannequin, such as retractions, can be reported verbally to the learners.

For more advanced learners, the patient can initially have limited air movement, which improves to wheezing with albuterol and ipratropium nebulizer treatments.

See the flow diagram in Figure 9.1 for further scenario changes described below.

Case narrative, continued

The patient will partially respond to supplemental oxygen, nebulizer treatments, corticosteroids, and epinephrine.

Repeat examination after treatment

Lungs: Diffuse wheezing bilaterally, tachypnea.

If the learner asks, the patient has less retractions.

For student learners, the case can end here after initial interventions and prior to decompensation.

After about 7 min, the patient will begin to decompensate. He now appears lethargic and becomes altered.

Repeat examination

General: Eyes closed, moans to deep stimuli, slumped in bed.

Lungs: Labored, agonal breathing, diffuse, bilateral wheezing.

Learner should initiate RSI, as in the critical actions.

Phase II: ventilator management (optional; for more advanced learners).

Vital signs following intubation: HR 110, RR ventilated rate, BP 115/85, O₂ sat 96% on ventilator.

Ideal Ventilator settings (to be given to the Respiratory Therapist by the learner):

- Mode: Assist control (A/C).
- Tidal volume (TV): 6–8 mL/kg.
- Respiratory rate (RR): 6–8 breaths per minute.
- Inspiratory to expiratory ratio (I:E): 1:4–5.

If the learner sets the RR >8 and/or a TV >8 mL/kg, the patient will develop a pneumothorax that rapidly progresses to a tension pneumothorax.

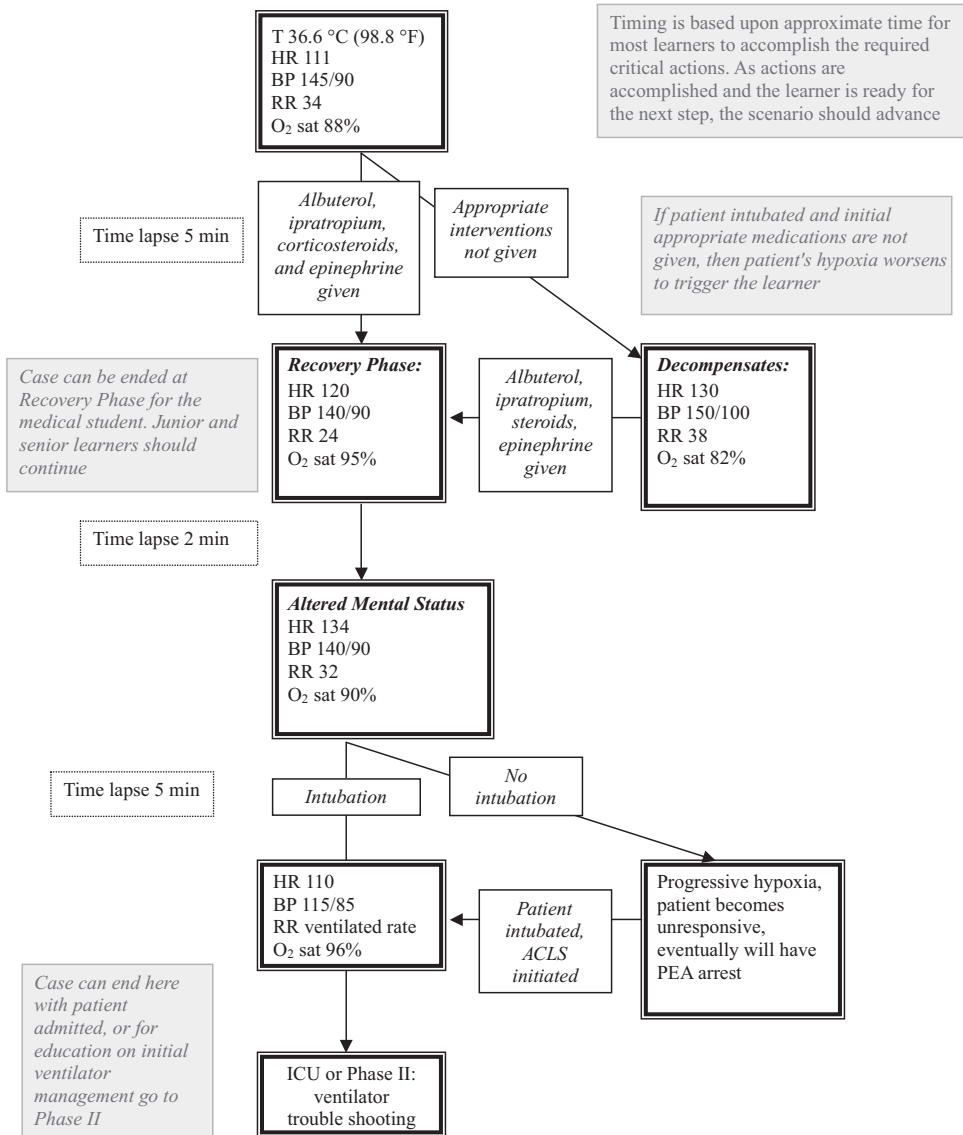


Figure 9.1 Scenario flow diagram: status asthmaticus.

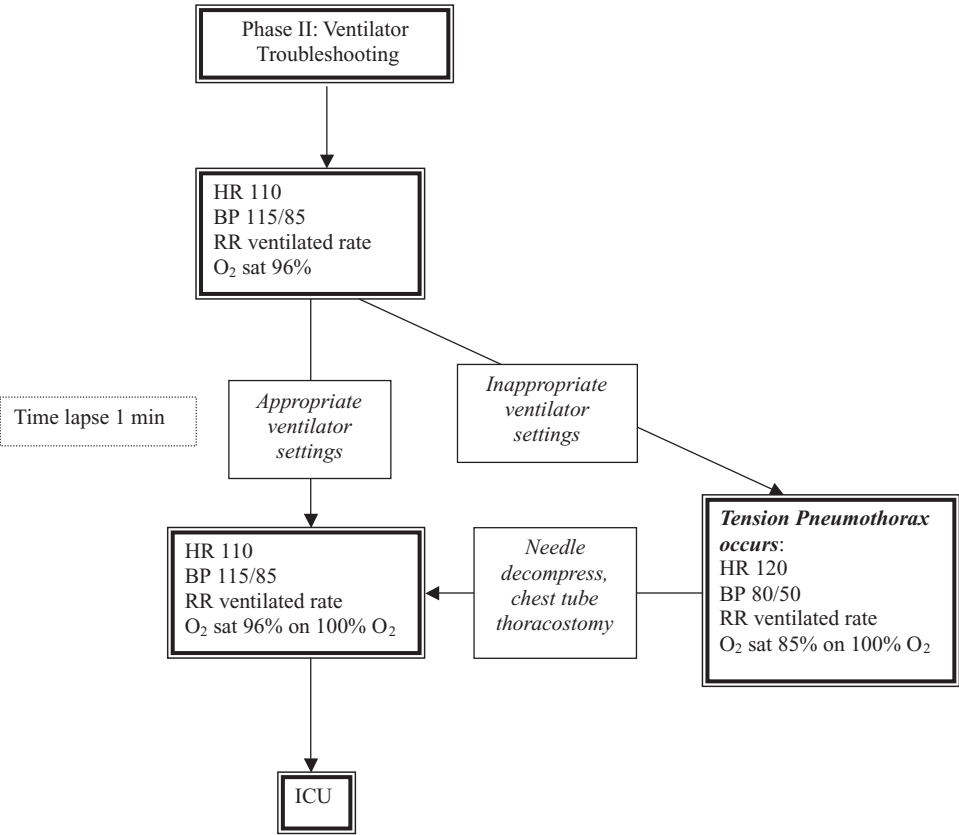


Figure 9.1 (Continued)

Instructor notes

Pathophysiology

- Asthma is a chronic airway inflammatory disorder leading to bronchial hyper-responsiveness and increased mucous production.

Clinical features

- Shortness of breath.
- Chest tightness.
- Diffuse expiratory wheezing.

Diagnosis

- Primarily clinical. It includes physical examination findings as stated above, and responsiveness to appropriate treatment.

Management

- Oxygen:
 - Provided to maintain O₂ sat above 92%.
- Peak expiratory flow (PEF):
 - Used to assess response to treatment and severity of exacerbation.
- Inhaled short-acting β_2 -adrenergic agonists:
 - Albuterol 2.5 mg nebulized solution every 20 min as needed.
 - Continuous nebulized albuterol at 10–15 mg/h is also acceptable.
- Anticholinergics:
 - Ipratropium 0.5 mg nebulized solution can be given every 20 min, up to a maximum of three doses.
- Corticosteroids:
 - Prednisone (or equivalent) 40–80 mg orally once daily, or divided every 12 h, for up to 5 days.
 - In severe exacerbations, or unable to take PO, give methylprednisolone 125 mg IV, up to a maximum of 250 mg IV.
- Adrenergic agents:
 - Epinephrine (1:1000 solution) 0.3 mg SQ or IM every 20 min, for a maximum of three doses.
 - Terbutaline 0.25 mg SQ every 30 min, for a maximum of two doses.
 - Caution with use in elderly patients and in those with heart disease.
- Antibiotics:
 - Not recommended unless there is evidence for a bacterial infection.
- Non-invasive ventilation:
 - There is an increasing body of literature that recommends the use of non-invasive positive-pressure ventilation to prevent intubation in severe asthmatics.
- Mechanical ventilation:
 - Does not solve the problem of airway obstruction.
 - Can lead to several complications, such as barotrauma, pneumothorax, increased airway pressures, and hypotension.

- The appropriate initial settings are A/C, low TV (6–8 mL/kg), low RR (6–8 breaths/min), and increased I:E ratios (1:4–5).
- Sedation should be used initially to decrease the work of breathing.

Debriefing plan

Plan for ~30 min for discussion.

Potential questions for discussion

- What is the medical management for an acute asthma exacerbation?
- When should intravenous versus oral steroids be administered?
- Which patients should be given epinephrine? What is the correct dose? How should it be given?
- Which patients require a hospital admission?
- What are the key concepts in ventilator management in an acute asthma exacerbation?

Selected reading

1. Lazarus S. Emergency treatment of asthma. *N Engl J Med* 2010;**363**(8):755–764.
2. EPR-3. *Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma: Full Report* 2007. NIH Publication No. 08-4051. Bethesda, MD: US Department of Health and Human Services, National Institutes of Health, National Heart, Lung, and Blood Institute, and National Asthma Education and Prevention Program, 2007.
3. American Heart Association. 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Part 10.5: Near-Fatal Asthma. *Circulation* 2005;**112**:IV-139–IV-142.

Hemoptysis

Educational goals

Learning objectives

Primary:

1. Recognize clinical signs and symptoms associated with hemoptysis [*Medical Knowledge*].
2. Recognize and verbalize the initial management of a patient with hemoptysis. [*Patient Care, Medical Knowledge*].
3. Generate a differential diagnosis, and begin the correct medical work-up once the patient is stabilized [*Medical Knowledge, Patient Care, Systems-based Practice*].
4. Demonstrate the appropriate treatment for hemoptysis [*Patient Care, Medical Knowledge*].

Secondary:

1. Demonstrate professionalism and communication skills when consulting the intensive care unit (ICU) and other consultants, and while working with ED personnel [*Interpersonal and Communication Skills, Professionalism*].
2. Direct proper disposition and the appropriate consultation(s) [*Patient Care, Systems-based Practice*].

Critical actions checklist

- ☐ Assess airway, breathing, circulation (ABCs), and correct abnormalities as they are detected [*Patient Care, Medical Knowledge*]
- ☐ Place the patient on a cardiac monitor and obtain heart rate, blood pressure, and oxygen saturation (O₂ sat) [*Patient Care*]
- ☐ Place two large-bore IVs (at least 18 gauge) [*Patient Care*]
- ☐ Resuscitation with IV crystalloids, followed by colloids (blood) [*Medical Knowledge, Patient Care*]
- ☐ Recognize need for airway protection and perform successful endotracheal intubation [*Medical Knowledge, Patient Care*]
- ☐ Direct appropriate disposition of patient to an ICU [*Patient Care*]

Critical actions can be changed to address the educational needs of the learner. For example: a resident preparing for oral boards may have more specific critical actions oriented towards oral board review (i.e. consult and interact appropriately with critical care physician, pulmonologist, cardiothoracic surgeon as necessary, etc.)

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin, no moulage, on a stretcher or hospital bed holding an emesis basin. Mannequin should be female.

Props: To be displayed on plasma screen/computer screen or printed out on handouts in the scenario room when asked for/return from laboratory:

- Images (see online component for Hemoptysis, *Scenario 9.2.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG with tachycardia.
 - Posteroanterior and lateral chest X-ray that shows normal cardiac silhouette, and right upper lobe lung mass.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Type and screen.
 - Liver function tests.
 - Coagulation panel.

Available in the treatment room:

- Basic airway and code cart.
- Oxygen.
- IV fluids [normal saline (NS) or lactated Ringer's (LR)].
- Bags of red fluid labeled as O-negative blood.

Distractor: None.

Actors:

- Paramedic(s) can provide information about the scene.
- Husband can provide the patient's medical history, medications, and medication allergies.
- Patient voice is female. Patient should initially be awake and alert, answering questions appropriately.
- ED nurse(s) can start IVs and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed.
- ICU physician, pulmonologist, anesthesiologist, cardiothoracic surgeon, and gastroenterologist can be available via "phone consultation" as needed.

Case narrative

Scenario background

A 54-year-old female was brought in by ambulance with a complaint of coughing up a cup of bright red blood. She has been coughing up blood-streaked sputum for 2 weeks. She also complains of some shortness of breath during the past 2 weeks, worsened with coughing. The patient denies any chest pain, lightheadedness, or dizziness.

Background may be presented prior to case, by EMS/ husband, or given as a triage sheet.

CC: Coughing up blood.

PMH: Back pain.

Meds: Ibuprofen as needed.

Allergies: None.

Family Hx: Unremarkable.

Social Hx: Lives with husband; has smoked one pack of cigarettes per day for 32 years; drinks 2–3 glasses of wine per day.

Initial scenario conditions

The patient is a comfortable-appearing, awake, and alert female. She can answer questions appropriately.

Alternatively, for the advanced learner, the patient can be obtunded on arrival and unable to provide a medical history, and the initial vital signs can be altered to make the patient more critical on arrival at the ED.

Vital signs: Temp. 36 °C (97.6 °F), HR 104, RR 18, BP 95/68, O₂ sat 94% RA.

Fingerstick glucose test: 101.

General: No apparent distress, seated comfortably on the stretcher, speaking in full sentences.

Eyes: Pupils equal, round, and reactive to light, pale conjunctiva.

Heart: Regular rate and rhythm, no murmurs, rubs, or gallops.

Lungs: Tachypnea, slightly decreased breath sounds on the right upper lobe; no rales, rhonchi, or wheezing.

Abdomen: Soft, non-distended, non-tender, normal bowel sounds; guaiac positive brown stool.

Physical examination findings not available on your mannequin can be reported verbally if asked for by the learners. For example, pale conjunctiva should be relayed to the learner who asks. Similarly, if your mannequin is unable to simulate decreased breath sounds to the right upper lobe, this should be conveyed to the learner by the nurse, as it is an important examination finding.

See the flow diagram in Figure 9.2 for further scenario changes described below.

Case narrative, continued

If the patient is placed on a monitor and given oxygen and IV fluids, there will be some response to the initial treatment.

Following initial stabilization, labs and imaging (if ordered) become available.

As the participants are reviewing the laboratory results, the patient has several episodes of hemoptysis, totaling about 250 mL.

Hemoptysis can be simulated with a basin of “blood” made with water dyed with red food coloring, and using a sound effect of coughing to come from the simulator or programmer.

Repeat examination following hemoptysis

General: Diaphoretic, anxious, pale, less arousable.

Heart: Tachycardic, regular; no murmurs, rubs, or gallops.

Lungs: Slightly decreased breath sounds on the right upper lobe; new rhonchi developed in lower right lung; tachypneic.

Physical examination findings that cannot be simulated by your mannequin should be reported to the learner. For example, the nurse can report, “Look how much she is sweating,” and “She feels so cold.” The lung findings should be stated as before, as this is an important part of the exercise.

At this point, the patient should be intubated and transfused packed red blood cells. Given the likely source of bleeding in the right upper lobe, the patient can be placed in the right lateral decubitus position, to improve aeration of the left lung.

The intensivist should be called at this time for an admission to the ICU.

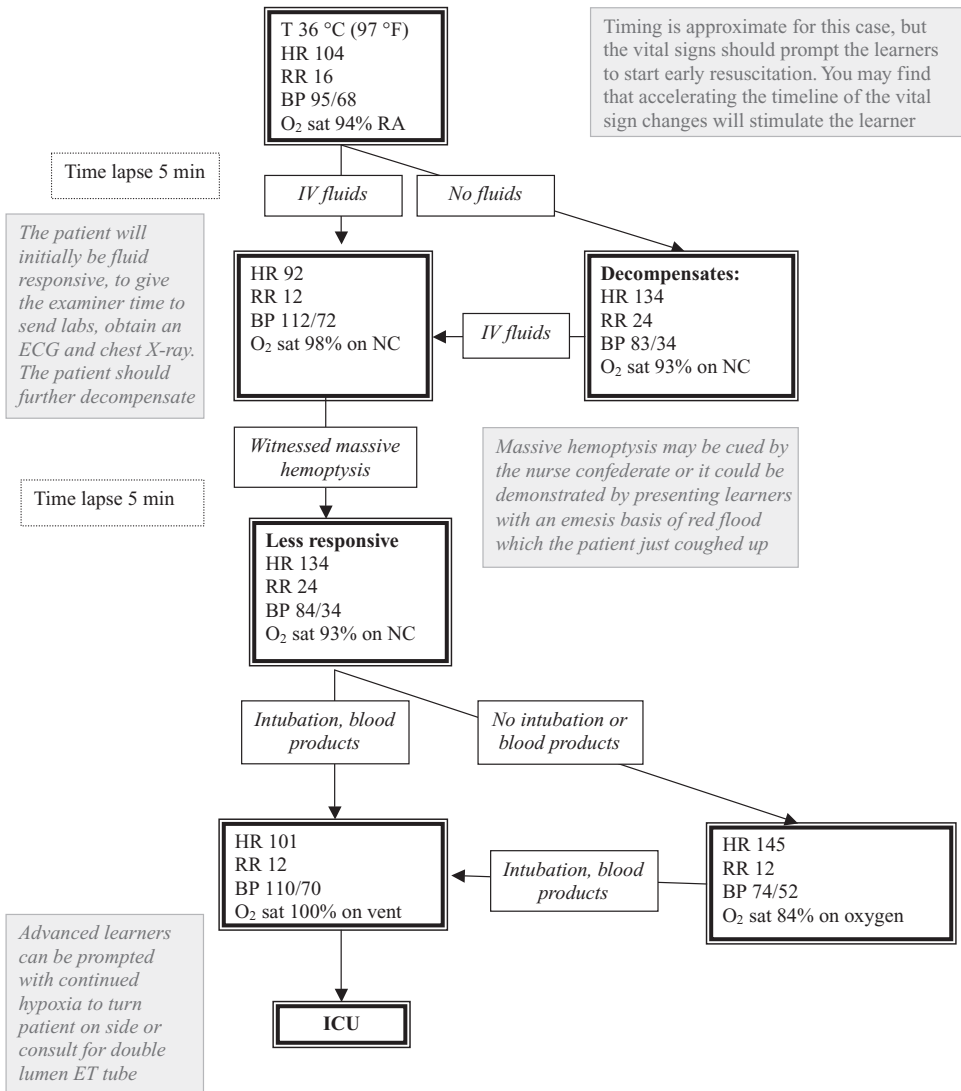


Figure 9.2 Scenario flow diagram: hemoptysis.

Instructor notes

Background

- The term “massive hemoptysis” is reserved for life-threatening bleeding:
 - Occurs in less than 5% of hemoptysis cases.
 - Mortality associated with massive hemoptysis can be as high as 80%.

Clinical features

- Massive hemoptysis is defined as >600 mL blood in 24 h in an adult patient:
 - Mild hemoptysis <20 mL/24 h.
 - Moderate hemoptysis 20–600 mL/24 h.

Differential diagnosis

- In cases of hemoptysis, it is important to consider gastrointestinal in addition to pulmonary causes.
- The differential diagnosis of massive hemoptysis can be remembered with the mnemonic “BATTLE CAMP”:
 - B – bronchitis, bronchiectasis
 - A – aspergillosis
 - T – tuberculosis (TB), ruptured Rasmussen’s aneurysm
 - T – tumor
 - L – lung abscess or mass
 - E – embolus (pulmonary embolus)
 - C – cocaine abuse
 - A – arteriovenous malformation (AVM), autoimmune disease
 - M – mitral stenosis or congenital heart disease
 - P – pneumonia

Diagnosis

- Chest X-rays may show evidence of lesions, such as neoplasms.
- Fiber-optic bronchoscopy is useful to identify lesions and localize the source of bleeding, and also to take biopsy samples.
- High-resolution computed tomography (CT) may demonstrate lesions that are beyond the reach of bronchoscopes.
- Arteriography can be used for the diagnosis of massive bleeds, and also for treatment with embolization.

Management

- Correct hypoxia or hypoxemia with oxygen:
 - If the bleeding source is known, the patient should be positioned on their side, with the lesion in the dependent position.
 - Consider intubation for airway protection early in these cases.
 - Selective airway techniques, such as right mainstem intubation (left lung bleeding), or the use of a double lumen endotracheal tube can be used. However, only experienced providers should place them once the patient is stabilized.
- Establish large-bore IVs or central venous access:

- Administer IV crystalloids, followed by colloids.
- Correct any underlying coagulopathy, such as those caused by anticoagulation medications.
- Start antibiotics in a patient with concern for infectious causes, fever, or leukocytosis:
 - In cases of suspected tuberculosis, the patients should be isolated to prevent spread of the disease.
- Consult with critical care, pulmonology, interventional radiology, and/or surgery for continued management and definitive care:
 - Consider urgent bronchoscopy versus bronchial artery angiography after intubation for direct control of bleeding.
 - A partial lung resection may be necessary if the bleeding cannot be controlled.
 - Endovascular interventions have recently become more effective as an alternative to surgery.

Debriefing plan

Plan for ~30 min for discussion.

Potential questions for discussion

- What is “massive hemoptysis?”
- Why is important to recognize this condition quickly?
- What are the most common causes of massive hemoptysis?
- What are the indications for intubation in these patients?

Selected reading

1. Jean-Baptiste E. Clinical assessment and management of massive hemoptysis. *Crit Care Med* 2000;28(5):1642–1647.
2. Lordan JL, Gascoigne A, Corris PA. The pulmonary physicians in critical care – illustrative case 7: assessment and management of massive haemoptysis. *Thorax* 2003;58(9):814–819.

Sepsis

Educational goals

Learning objectives

Primary:

1. Recognize and list the distinctions between systemic inflammatory response syndrome (SIRS), infection, sepsis, severe sepsis, and septic shock [*Medical Knowledge*].
2. Demonstrate the steps involved in the initial stabilization and resuscitation of a patient with sepsis [*Patient Care, Medical Knowledge*].
3. Demonstrate appropriate treatment and management of the patient in accordance with current and updated sepsis guidelines [*Medical Knowledge, Patient Care, Systems-based Practice*].

Secondary:

1. Demonstrate professionalism and communication skills in consulting the intensive care unit (ICU), and while working with ED personnel [*Interpersonal and Communication Skills, Professionalism*].
2. Direct proper disposition and obtain appropriate consultation(s) [*Systems-based Practice*].

Critical actions checklist

- ☐ Assess airway, breathing, circulation (ABCs), and correct abnormalities as they are detected [*Patient Care, Medical Knowledge*]
- ☐ Monitor the heart rate, blood pressure, respirations, and oxygen saturation [*Patient Care*]
- ☐ Place two large-bore IVs (alternatively, a central line can be placed) [*Patient Care*]
- ☐ Resuscitate with crystalloids and add vasopressors as necessary [*Patient Care, Medical Knowledge*]
- ☐ Administer appropriate antibiotics [*Patient Care*]
- ☐ Manage the airway with intubation [*Patient Care*]

Critical actions can be changed to address the educational needs of the learner. For example, a student learner may be expected to provide fluid resuscitation, identify sepsis, and administer antibiotics, whereas a more advanced learner may be expected to interpret central venous pressure (CVP) and central venous oxygen saturation (SvO₂) measurements and initiate vasopressors.

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin, no moulage, on a stretcher or hospital bed. Mannequin should be male.

Props: To be displayed on plasma screen/computer screen or printed out on handouts in the scenario room when asked for/return from laboratory:

- Images (see online component for Sepsis, *Scenario 9.3.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG with sinus tachycardia.
 - Portable chest X-ray that shows a normal cardiac silhouette and multifocal patchy pneumonia.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Liver function tests.
 - Venous lactate.
 - Coagulation panel.
 - Type and screen.
 - Urinalysis.
 - Arterial blood gas.
 - CVP and SvO₂ measurements after initial resuscitation.

Available in the treatment room:

- Basic airway and code cart.
- Peripheral IV and central venous access kit.
- Nasal cannula and non-rebreather mask (NRB).
- Normal saline (NS) liter bags.
- Broad-spectrum antibiotics:
 - E.g. vancomycin, piperacillin/tazobactam, cefipime in separate labeled bags.
- Acetaminophen, oral and rectal formulations.
- Vasopressors:
 - E.g. norepinephrine IV, in a labeled bag.
 - E.g. phenylephrine IV boluses, in labeled syringes.
- Labeled syringes with methylprednisolone or hydrocortisone.
- Intubation medications.
- Bags of red fluid labeled as O-negative blood.
- Central venous pressure and central venous oxygen saturation monitoring equipment (if central line placed).

Distractor: None.

Actors:

- Paramedic(s) provide information about the scene.
- Wife can provide the patient's medical history, medications, and medication allergies.
- Patient voice is male. Patient should initially appear tired, but awake and alert, and answering questions appropriately.
- ED nurse(s) can start IVs and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed.
- ICU physician can be available via "phone consultation."

Case narrative

Scenario background

A 78-year-old male was brought in by ambulance with a complaint of feeling tired for 3–4 days. He has been coughing for 4 days, productive of yellowish green sputum. He states that he becomes short of breath with coughing and ambulation. The patient also complains of being lightheaded when he tries to get out of bed, a decreased appetite for 2 days (he has been able to drink some soup during that time), and decreased urination for 2 days. He denies any chest pain.

According to the paramedics, the patient was found lying in bed. He appeared lethargic, and was unable to get out of bed unassisted.

Background may be presented prior to case, by EMS or the patient's wife, or given as a triage sheet

CC: "I feel tired."

PMH: Hypertension, hyperlipidemia, diabetes.

Meds: Metoprolol, simvastatin, aspirin, metformin.

Allergies: None.

Family Hx: Unremarkable.

Social Hx: Lives with wife; retired grocer; has smoked half a pack of cigarettes per day for 53 years; no alcohol, no illicit drug use.

Initial scenario conditions

Patient is an elderly male who is initially awake and answering questions.

Alternatively, the patient can be obtunded on arrival, unable to provide a medical history. The initial vital signs can be altered to make the patient more critical on arrival at the ED.

Vital signs: Temp. (oral) 39 °C (102.3 °F), HR 123, RR 24, BP 91/53, O₂ sat 90% RA.

Fingerstick glucose test: 258.

General: Lethargic, slow to answer, speaking 3–4 words between breaths.

Heart: Regular, tachycardia; no murmurs, rubs, or gallops.

Lungs: Tachypnea, no retractions, rhonchi bilaterally with some crackles.

Abdomen: Soft, non-distended, non-tender, normal bowel sounds.

Rectal: Guaiac negative, brown stool.

Extremities: Warm and perfused, no edema.

Physical examination findings not available on your mannequin can be reported verbally if asked for by the learners. For example, a learner who asks about the rectal examination should be given the examination findings as outlined above.

See the flow diagram in Figure 9.3 for further scenario changes described below.

Case narrative, continued

If the patient is placed on a monitor and given oxygen, antipyretics, and IV crystalloids, there will be some response to the initial treatment.

Labs should be ordered, and broad-spectrum antibiotics should be started for SIRS with presumed infection; alternatively, antibiotics can be given to target the lungs, the most likely source of the infection. A chest X-ray should be ordered and is available. A bedside ECG should be ordered and is available.

Patient can be given a lower hematocrit of <30 to prompt more advanced learners to initiate blood transfusion according to sepsis management protocols.

Once the learner has looked at the chest X-ray, ECG, and labs, the patient begins to decompensate.

Case can end prior to decompensation for student learners.

Repeat examination at time of decompensation

General: Diaphoretic.

Mental status: Moans to deep stimuli only, eyes closed.

The patient should have a central line placed, be started on vasopressors titrated to a mean arterial pressure (MAP) of 65, intubated, and admitted to the ICU.

For more advanced learners and depending on the learning objectives, prior to the ICU admission, CVP measurements and SvO_2 values can be given to prompt further resuscitation. In addition, the patient can have vasopressor-resistant shock and may begin steroid therapy depending on the learning focus.

Remember to focus the teaching points for each simulation session. It is not recommended to provide all of the possible complications to this difficult case unless the learner is very advanced.

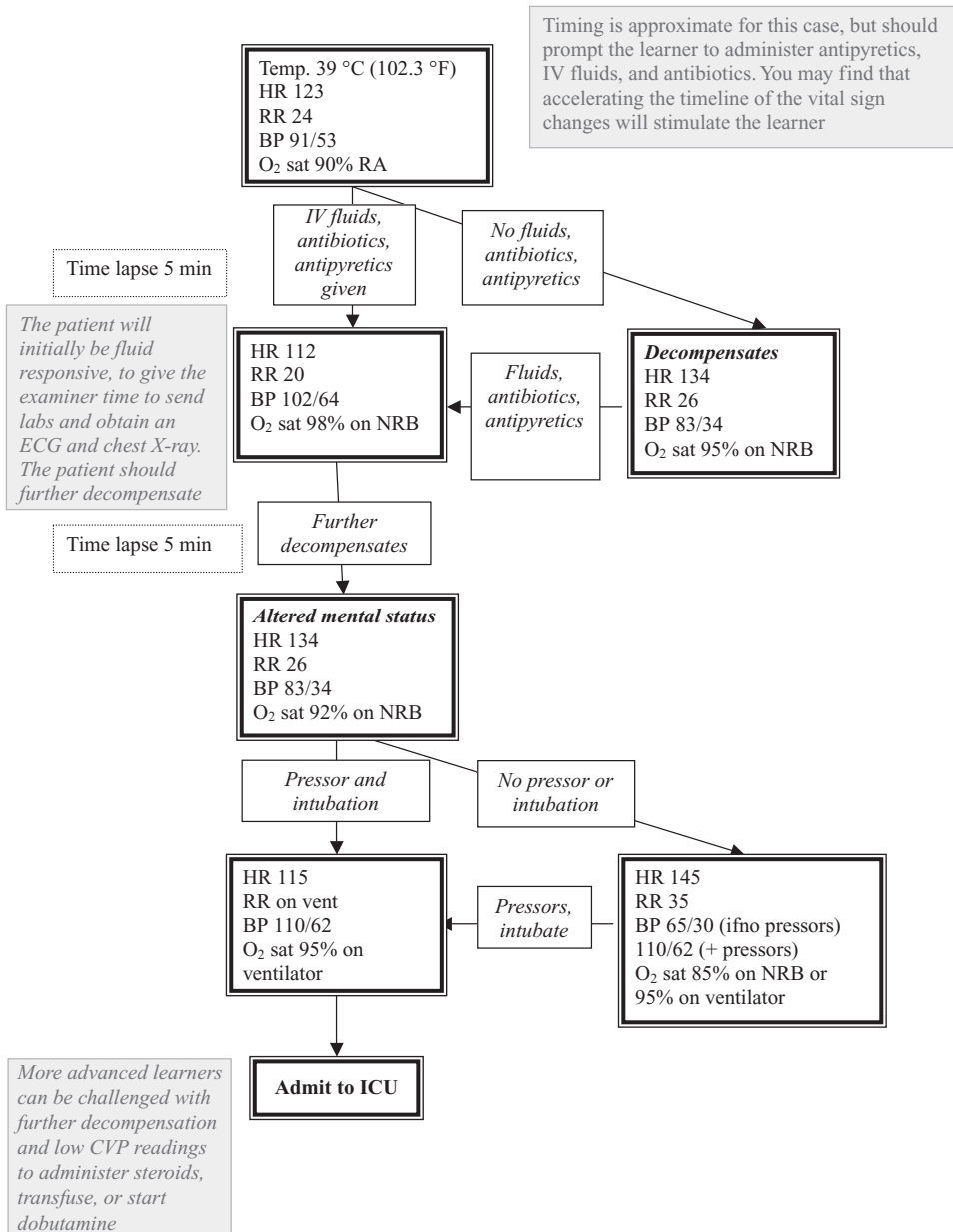


Figure 9.3 Scenario flow diagram: sepsis.

Instructor notes

Background

- Sepsis is associated with high mortality rates and lengthy hospital stays, both of which are improved with early resuscitation and administration of broad-spectrum antibiotics.

Diagnosis

- Sepsis is on a continuum from SIRS to septic shock:
 - SIRS is defined as follows: WBC count of $>12\,000$, <4000 , or $>10\%$ bands; heart rate >90 , respiratory rate of >20 or partial pressure of carbon dioxide ($PaCO_2$) <32 ; temperature $>38.3\text{ }^{\circ}\text{C}$ or $<36\text{ }^{\circ}\text{C}$.
 - Sepsis is manifested in a patient who meets the SIRS criteria, and has a documented source of infection:
 - Severe sepsis consists of multi-organ failure, hypotension, and an elevated lactate level.
 - Septic shock is defined as persistent hypotension, despite fluid administration:
 - Septic shock can further be defined as fluid or catecholamine responsive or resistant.

Management

- Emergency department work-up should include:
 - Labs:
 - Complete blood count, basic metabolic panel, venous lactate, type and screen, urinalysis, urine culture, and blood cultures.
 - Imaging:
 - A chest X-ray should be ordered to assess for consolidations as a source of sepsis.
 - In cases where no source is found and when indicated, lumbar puncture should be performed.
- Resuscitation guidelines:
 - CVP 8–12 mmHg, MAP >65 mmHg:
 - Fluids initially, add vasopressors if needed:
 - Preference given to norepinephrine (dopamine also acceptable) as first choice, steroids for catecholamine-resistant shock.
 - CVP goal around 12 mmHg in mechanically ventilated patients.
 - CVP monitoring most accurate from an internal jugular or subclavian line.
 - Mean urine output (UOP) $>0.5\text{ ml/kg/h}$:
 - Foley catheter is needed to ensure adequate UOP.
 - Central venous O_2 sat $\geq 70\%$ or mixed venous $\geq 65\%$:
 - Manage with fluid resuscitation.
 - Blood transfusion as needed.
 - Dobutamine if necessary at maximum $20\text{ }\mu\text{g/kg/min}$.

- Antibiotic guidelines:
 - Start broad-spectrum antibiotic or source-directed therapy within 1 h of recognizing shock.
 - Consider *Pseudomonas* coverage and double coverage for pathogen-suspected infections.
- Oxygenation/airway guidelines:
 - Intubation should be considered early in any patient with hemodynamic instability, altered mental status, or evidence of acute lung injury (ALI) or acute respiratory distress syndrome (ARDS).
 - Ventilation management should follow the strategy of maximizing oxygenation while limiting lung injury:
 - Low TV (target 6 mL/kg).
 - Monitoring peak plateau pressures (goal ≤ 30 cmH₂O).
 - Targeting PEEP to minimize end expiratory lung collapse.
- Blood transfusion indications:
 - Patients with myocardial ischemia, severe hypoxia, cyanotic heart disease, lactic acidosis, and other signs of hypoperfusion should be transfused packed red blood cells to maintain a hemoglobin concentration of 7–9 g/dL.
- Early consultation with an intensivist and transfer to an ICU for continued management.

Debriefing plan

Plan for ~30 min for discussion.

Potential questions for discussion

- Define infection, systemic inflammatory response, sepsis, severe sepsis, and septic shock.
- Explain your choice of antibiotics. What organisms will these antibiotics cover?
- When are vasopressors indicated? What is the evidence?
- When are steroids indicated?
- What can we learn from a single lactate level? What information can we learn from a trend in the lactate level? Is the venous lactate level comparable to an arterial sample?
- When should a patient be intubated?
- What are the appropriate ventilator settings for a patient with sepsis and/or ARDS?
- When should invasive monitoring be used, including arterial lines and central venous pressure monitors?

Selected reading

1. Levy MM, Dellinger RP, Townsend SR, *et al.* The Surviving Sepsis Campaign: results of an international guideline-based performance improvement program targeting severe sepsis. *Intensive Care Med* 2010;**36**(2):222–231.
2. Townsend SR, Schorr C, Levy MM, *et al.* Reducing mortality in severe sepsis: the Surviving Sepsis Campaign. *Crit Care Med* 2008;**29**(4):721–733.

3. Dellinger RP, Levy MM, Carlet JM, *et al.* Surviving Sepsis Campaign: international guidelines for management of severe sepsis and septic shock. *Crit Care Med* 2008;**36**(1):296–327.
4. Rivers E, Nguyen B, Havstad S, *et al.* Early goal-directed therapy in the treatment of severe sepsis and septic shock. *N Engl J Med* 2001;**345**(19):1368–1377.
5. DeBacker D, Biston P, Devriendt J, *et al.* Comparison of dopamine and norepinephrine in the treatment of shock. *N Engl J Med* 2010;**362**(9):779–789.
6. Catenacci MH, King K. Severe sepsis and septic shock: improving outcomes in the Emergency Department. *Emerg Med Clin N Am* 2008;**26**(3):603–623.
7. See also: www.survivingsepsis.org and www.ardsnet.org. (last accessed May 15, 2012).

CHAPTER 10 Toxicologic emergencies

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Digoxin overdose

Educational goals

Learning objectives

Primary:

1. Recognize clinical signs of digoxin toxicity [*Medical Knowledge*].
2. Demonstrate appropriate treatment for digoxin toxicity [*Medical Knowledge, Patient Care*].

Secondary:

1. Demonstrate professionalism and communication skills when consulting the Intensive Care Unit (ICU) and working with the Emergency Department (ED) nurse [*Interpersonal and Communication Skills, Professionalism*].
2. Direct proper disposition/appropriate consultation [*Systems-based Practice*].

Critical actions checklist

- ☐ Obtain fingerstick glucose test or administer empiric dextrose and thiamine [*Medical Knowledge*]
- ☐ Order ECG and recognize high-grade atrioventricular (AV) block in setting of digoxin overdose [*Medical Knowledge*]
- ☐ Administer atropine [*Medical Knowledge*]
- ☐ Treat hyperkalemia with IV sodium bicarbonate, inhaled β -adrenergic agonists, insulin, and glucose [*Medical Knowledge*]
- ☐ Use Digoxin Fab fragments (Digibind) in the setting of bradycardic dysrhythmia and AV block [*Medical Knowledge*]
- ☐ Perform cardiac pacing at lowest setting that allows capture [*Medical Knowledge*]
- ☐ Administer activated charcoal after the airway is secured [*Medical Knowledge*]
- ☐ Treat unstable ventricular tachycardia (VT) with lidocaine, phenytoin, or defibrillation [*Medical Knowledge*]
- ☐ Call and communicate to Cardiac Care Unit (CCU) for disposition [*Interpersonal and Communication Skills, Professionalism*]

Critical actions can be changed to address the educational needs of the learner. For example, a resident preparing for oral boards may have more specific critical actions oriented towards oral board review (e.g. consult psychiatry, order pregnancy test, etc.)

Emergency Medicine Simulation Workbook: A Tool for Bringing the Curriculum to Life, First Edition. Edited by Traci L. Thoureen and Sara B. Scott.

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Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin, no moulage, on a stretcher or hospital bed. The mannequin should be female.

Props: To be displayed on plasma screen/computer screen or printed out on handouts in the scenario room when asked for/return from laboratory:

- Images (see online component for Digoxin Overdose, *Scenario 10.1.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG with complete heart block.
 - Preliminary radiology read of normal head CT.
 - Preliminary radiology read of normal chest x-ray.
- Labs (see online component as above):
 - Complete blood count.
 - Complete metabolic panel.
 - Cardiac enzymes.
 - Pro-B natriuretic peptide.
 - Urinalysis.
 - Lactate.
 - Coagulation panel.
 - Digoxin level.
 - Urine toxicology screen.
 - Serum toxicology screen.

Available in the treatment room:

- Basic airway and code cart, including a defibrillator and pacer pads.
- Nebulizer mask.
- Medications (labeled bags/syringes may be used in place of actual medicine syringes or bags):
 - Ampules of calcium chloride/gluconate
 - Magnesium sulfate in labeled 100 mL bag
 - Intravenous fluids (IVFs): including normal saline (NS) and 5% dextrose in water (D5W).
 - Ampules of sodium bicarbonate and 50% dextrose (D50).
 - Regular insulin.
 - Albuterol solution for nebulization
 - Advanced Cardiac Life Support (ACLS) medications.
 - Activated charcoal.
 - Phenytoin.
 - Digoxin Fab fragments.

Distractor: None.

Actors:

- Paramedic(s) are able to provide information about the scene, including what pill bottles were found, but only if specifically asked.

Altering input from actors is a good way to increase/decrease scenario difficulty. For example, EMS may not know the past medical history of atrial fibrillation and digoxin.

- Husband. Optional person available to provide additional information either in person or via telephone.
- Patient voice is female. Patient should be moaning and confused. Obtaining a history from the patient should be difficult.
- ED nurse can start IVs and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed.
- Poison control available via “phone consultation” Option: to increase difficulty, you can make poison control unavailable.
- ICU physician can be available via “phone consultation.”

Case narrative

Scenario background

A 56-year-old female is brought in by paramedics from home. According to paramedics, she has had altered mental status for the last 2 h. She has a history of atrial fibrillation and has been feeling unwell for 3 days with cough and cold symptoms. She has also complained of blurred vision and headache. Her doctor recently saw her for the cold and prescribed an unknown antibiotic.

Background may be presented prior to case, by EMS, or given as a triage sheet.

For students or junior learners, paramedics may have the “unknown” antibiotic pill bottle labeled as azithromycin.

CC: Change in mental status.

PMH: Atrial fibrillation.

Meds: Azithromycin, digoxin (option: to increase case difficulty, you could make this information unknown).

Allergies: Sulfonamides.

Family Hx: Unremarkable.

Social Hx: No smoking, occasional alcohol, no illicit drugs.

Initial scenario conditions

A middle aged, lethargic female, who is moaning, but arousable.

VS: Temp 38°C (100.4°F), HR 35, RR 14, BP 95/60, O₂ sat 97% RA.

Eyes: Pupils equal, dilated, reactive.

Heart: Bradycardia, no murmurs.

Lungs: Equal bilaterally, clear to auscultation.

Neurologic: Slurred speech, opens eyes in response to voice, uttering inappropriate words, withdraws to painful stimuli.

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners, e.g. if your mannequin does not have reactive pupils you can verbally report the pupillary examination when it is requested.

See the flow diagram in Figure 10.1 for further scenario changes described below.

Case narrative, continued

ECG or monitor tracing should be obtained immediately. Patient will stabilize if transcutaneous pacing is initiated. Repeat the examination after the patient is paced. The patient is now more arousable and can answer basic questions. She can now give the learner her history.

Heart: Regular rate and rhythm, no murmur.

Neurologic: Improved speech, able to answer questions, move arms and legs to command. If being paced, she complains of pain from the shocks of the transcutaneous pacer.

If no pacing is started in the first 2 min, then the rhythm will change to ventricular tachycardia. This patient will require phenytoin, lidocaine, magnesium or defibrillation to convert her rhythm. She will not convert if amiodarone is the only intervention.

After 5 min or completion of the above tasks, the initial potassium returns, showing hyperkalemia and digoxin toxicity. If they have been treated appropriately (see Critical Actions Checklist) then the patient will stabilize and is ready to be transported to the ICU after discussion with the ICU attending. If hyperkalemia is treated with calcium or not addressed, the case will end. If digoxin toxicity is ignored, the case will end.

Digoxin Fab fragments given at any time will result in patient stabilization. If the learners do not administer digoxin Fab fragments, then the ICU attending should prompt the administration of this antidote.

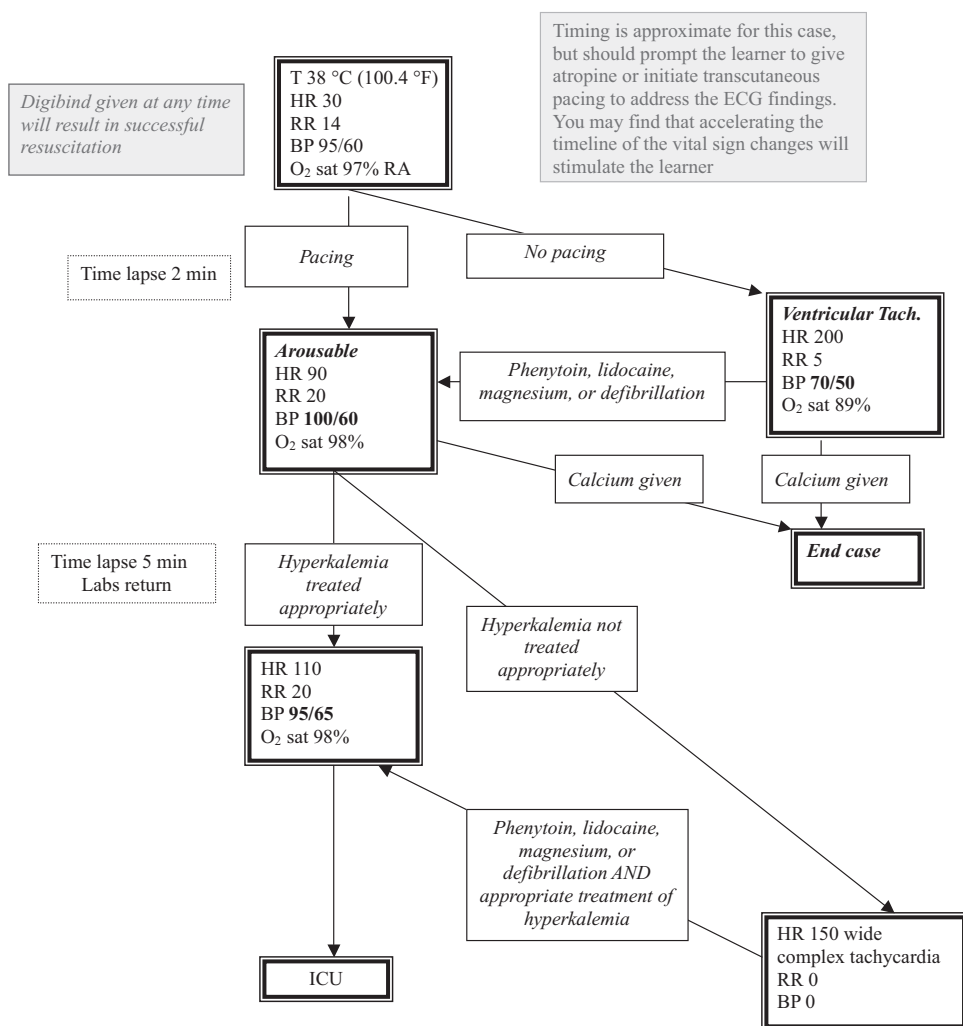


Figure 10.1 Scenario flow diagram: digoxin overdose.

Instructor notes

Pathophysiology

- Cardioactive steroids inhibit the sodium–potassium adenosine triphosphatase (Na–K ATPase) pump that increases cytoplasmic sodium and inhibits release of calcium from the cell.
- Sodium channel blockade → relative hypercalcemia.
- Macrolides can acutely increase the digoxin concentration.

Clinical features

- Altered mental status.
- Nausea, vomiting, abdominal pain.
- Visual disturbances.
- ECG changes:
 - Atrial tachycardia with AV block.
 - AV junctional block.
 - Sinus bradycardia (usually responsive to atropine).
 - Complete heart block.
- Hyperkalemia:
 - In acute digoxin poisoning, if serum potassium <5 meq/L, death is uncommon.
 - If potassium >5.5 meq/L, it is usually fatal.

Diagnosis

- Digoxin concentration >2 ng/mL at least 6 h after last ingestion.
- Digoxin-associated dysrhythmias in patient taking digoxin (see Clinical features above).

Management

- Activated charcoal.
- Digoxin-specific Fab (DigiFab) fragments:
 - Indicated for:
 - Any life-threatening dysrhythmia in patients taking digoxin.
 - Potassium >5.0 meq/L.
 - Digoxin concentration >15 ng/mL at any time or 10 ng/mL 6 h after the last dose.
 - Ingestion >10 mg in adults and 4 mg in children.
 - Dose can be calculated by (serum digoxin concentration × weight in kg)/100 or amount ingested (mg)/0.5 × 0.80.
 - If dose is unknown, therapy is 10–20 vials.
- Treat hyperkalemia:
 - Sodium bicarbonate:
 - Initial bolus is 1–2 meq/kg, repeated until QRS narrows.
 - Regular insulin 10 units with one ampule of D50.
 - Oral ion-exchange resin: sodium polystyrene sulfonate.

- Avoid calcium:
 - There is a theoretical risk of worsening the block in hyperkalemia with calcium treatment. Magnesium should be considered instead (See below).
- Manage dysrhythmias:
 - Tachydysrhythmias:
 - DigiFab is first-line therapy.
 - Magnesium:
 - Indicated for ventricular tachydysrhythmias in acute digoxin toxicity.
 - 2 g IV over 20 min with 1–2 g/h with serial monitoring of magnesium levels.
 - Therapy is contraindicated with bradycardia, AV block, or renal failure.
 - Phenytoin:
 - 100 mg IV every 5–10 min up to loading dose of 15 mg/kg.
 - Lidocaine:
 - 100 mg IV according to ACLS guidelines.
 - Defibrillation:
 - Use with caution as it may precipitate ventricular fibrillation.
 - Avoid amiodarone:
 - Decreases elimination of digoxin and has not been as well studied as the other drugs mentioned.
 - Bradydysrhythmias:
 - Atropine 0.5 mg IV.
 - Consider transcutaneous pacing if hemodynamically unstable.

Debriefing plan

Plan for ~30 min for discussion

Potential questions for discussion

- What is digoxin and what are its mechanisms of action?
- What are the characteristic ECG findings of acute digoxin overdose?
- What is the general emergency management of an overdose?
- What is the specific treatment for acute digoxin overdose?
- What are the expected physical examination and laboratory findings in digoxin overdose?
- What is a potentially lethal drug that could be given in digoxin overdose?

Selected reading

1. Hack JB. Cardioactive steroids. In: Nelson LS, Lewin NA, Howland MA, Hoffman RS, Goldfrank LR, Flomenbaum NE, eds. *Goldfrank's Toxicologic Emergencies*, 9th edn. New York: McGraw-Hill, 2010, pp. 936–945.
2. Chan ALF, Wang M-T, Su C-Y, Tsai F-H. Risk of digoxin intoxication caused by clarithromycin–digoxin interactions in heart failure patients: a population-based study. *Eur J Clin Pharmacol* 2009;**65**:1237–1243.
3. Rajapakse S. Management of yellow oleander poisoning. *Clin Toxicol* 2009;**4**:206–212.

Opioid overdose

Educational goals

Learning objectives

Primary:

1. Recognize clinical signs of opioid poisoning [*Medical Knowledge*].
2. Demonstrate appropriate treatment for opioid poisoning [*Medical Knowledge*].

Secondary:

1. Demonstrate professionalism and communication skills in working with ED nurse [*Interpersonal and Communication Skills, Professionalism*].

Critical actions checklist

- ☐ Assess airway, breathing, circulation (ABCs) [*Patient Care*]
- ☐ Obtain fingerstick glucose or administer empiric dextrose with thiamine [*Medical Knowledge*]
- ☐ Examine pupils and listen to bowel sounds in comatose, overdose patient [*Medical Knowledge, Patient Care*]
- ☐ Administer appropriate dose of naloxone [*Medical Knowledge*]
- ☐ Obtain serum acetaminophen concentration [*Medical Knowledge*]
- ☐ Call and communicate to admitting physician for disposition [*Interpersonal and Communication Skills, Professionalism*]
- ☐ Consult psychiatry [*Patient Care, Systems-Based Practice*]
- ☐ Administer N-acetylcysteine (optional scenario with co-ingestion of acetaminophen) [*Medical Knowledge, Patient Care*]

Critical actions can be changed to address the educational needs of the learner. For example, more senior learners may be required to address acetaminophen toxicity, in addition to the opioid overdose, whereas student learners may only need to manage the opioid overdose.

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin, no moulage, on a stretcher or hospital bed. The mannequin should be male.

Props: To be displayed on-screen or printed out on handouts in the scenario room when asked for/return from laboratory:

- Images (see online component for Opioid Overdose, *Scenario 10.2.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG with sinus tachycardia.
 - Preliminary radiology read of normal head CT.
 - Preliminary radiology read of normal chest X-ray.
- Labs (see online component as above):
 - Complete blood count.
 - Complete metabolic panel.
 - Cardiac enzymes.
 - Pro-B natriuretic peptide.
 - Urinalysis.
 - Lactate.
 - Coagulation panel.
 - Urine toxicology screen.
 - Serum toxicology screen (–acetaminophen).
 - Serum toxicology screen (+acetaminophen).

Choose the appropriate serum toxicology screen for your scenario.

Available in the treatment room:

- Basic airway and code cart.
- Medications (labeled bags/syringes may be used in place of actual medicine syringes or bags):
 - Intravenous fluids (IVFs): including normal saline (NS) and 5% dextrose in normal saline or lactate ringers (D5NS or D5LR).
 - Ampules of 50% dextrose (D50).
 - Naloxone vials.
 - N-Acetylcysteine (optional).

Distractor: None.

Actors:

- Paramedic(s) are able to provide information about the scene, including what pill bottles were found, but only if specifically asked.

Altering input from actors is a good way to increase/decrease the scenario difficulty. For example, if EMS did not find the pill bottle, the ingestion becomes unknown.

- Patient voice is male. Patient should sound somnolent with slurred speech and lethargy. Patient cannot give history until he has received an appropriate dose of naloxone.
- Co-worker. This may be an optional person available to provide additional information either in person or via telephone. For students or junior learners, they will be able to provide the pain medication name or bottle.
- ED nurse can start IVs and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed.
- Poison control available via “phone consultation.” Option: to increase difficulty, you can make poison control unavailable.
- Intensive care unit (ICU) physician can be available via “phone consultation.”

Case narrative

Scenario background

A 40-year-old man found unconscious at a bar after work. According to his work colleagues, he was in his usual state of health today. They do not know of any medical problems. He and his colleagues went to a bar to celebrate a new account. He had “a beer” at the bar and went outside. They found him slumped over on the sidewalk. His colleagues put him in the back of their car and drove him to the hospital.

If the patient receives naloxone, he may state that he took a handful of oxycodone today because he felt depressed and wanted to “end it.”

Option: To increase the degree of difficulty of the case, the patient took a handful of oxycodone/acetaminophen tablets.

Background may be presented prior to the case, by the patient’s friends, or given as a triage sheet.

CC: Somnolent.

PMH: Unknown.

Meds: Unknown (co-workers may have bottles of oxycodone for students or junior learners).

Allergies: None.

Family Hx: No family history.

Social Hx: “Social drinker, no drugs” (according to friends). “I don’t use drugs” (according to the patient).

Initial scenario conditions

The patient is a somnolent man, who is arousable to sternal rub (the nurse may comment that he smells like alcohol).

VS: T 37.1 °C (98.7 °F), HR 60, RR 8, BP 100/60, O₂ sat 88% RA.

Eyes: Pupils miotic and reactive.

Heart: Normal rate, no murmur.

Lungs: Equal bilaterally, clear to auscultation.

Abdomen: Decreased bowel sounds.

Skin: No track marks or needle marks.

Neurologic: Arouses to painful stimuli with eyes closed. No focal neurologic deficits.

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners. For example, if your mannequin does not have reactive pupils, you can verbally report the pupillary examination when it is requested.

See the flow diagram in Figure 10.2 for further scenario changes described below.

Case narrative, continued

Initially the patient presents with altered mental status. If given the appropriate dose of naloxone (0.05–0.1 mg) he improves and is arousable to voice with open eyes. If >1 mg of naloxone is given in single dose, then the patient exhibits opioid withdrawal symptoms: agitation, diaphoresis, and psychosis. He begins to scream, “They are trying to kill me!”

For student learners, the case can end here. Junior and senior learners should continue on and initiate a naloxone drip. If a drip is not initiated, the patient becomes more somnolent and hypotensive. If a naloxone drip or repeat doses of naloxone are not initiated within 10 min, the patient has a PEA arrest.

For more senior learners, an ingestion of oxycodone/acetaminophen may be used instead of oxycodone. The acetaminophen level will be 170 µg/mL (if it was ordered with labs). Because the time of initial ingestion is unknown, the patient should be given *N*-acetylcysteine.

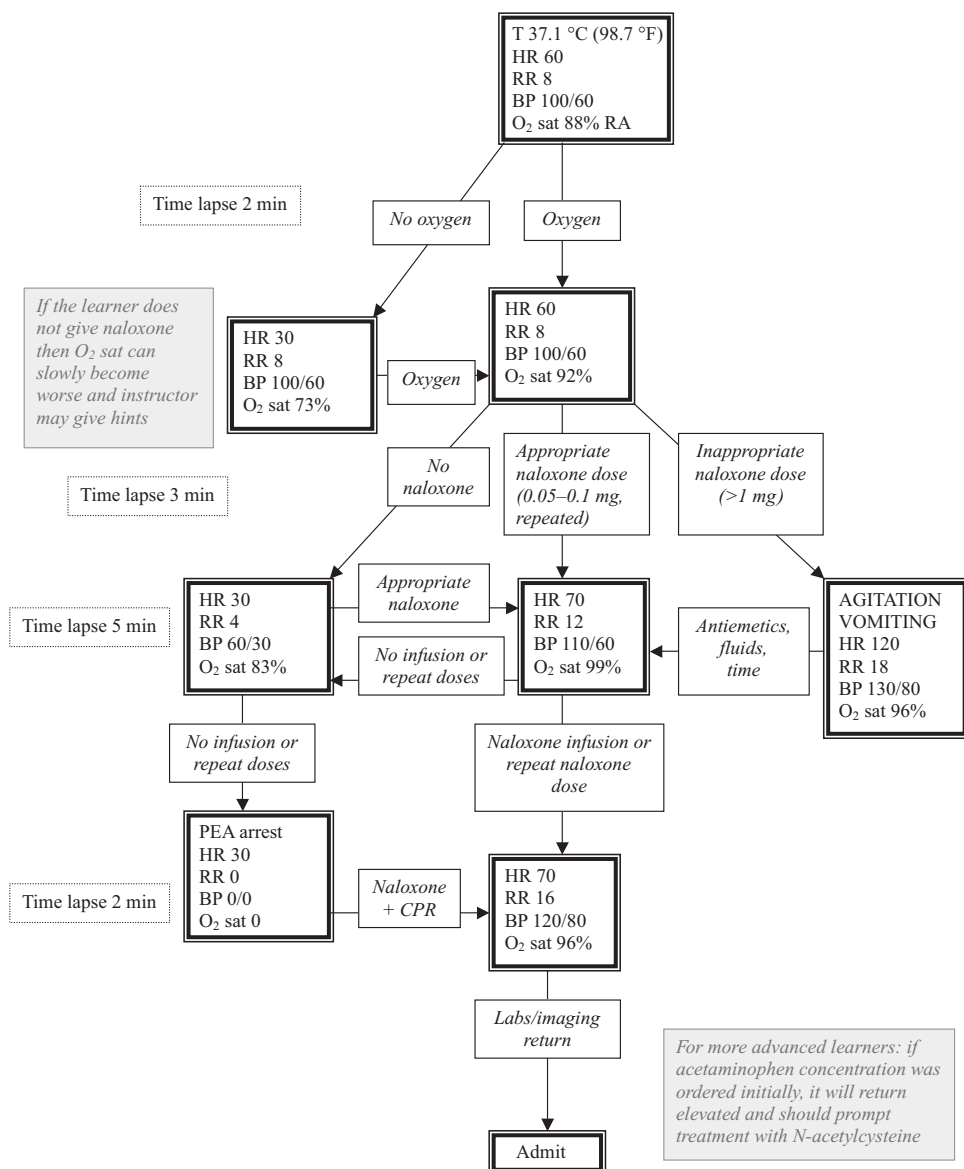


Figure 10.2 Scenario flow diagram: opiate overdose.

Instructor notes

Pathophysiology

- Oxycodone is an opioid, with activity at the μ receptor.

Clinical features

- Opioid toxidrome: somnolence, low/normal temperature, low/normal BP, low/normal HR, decreased RR, decreased bowel sounds, miotic pupils.

Diagnosis

- Primarily clinical.
- Oxycodone is a semi-synthetic opioid, it usually does not show up on standard urine toxicology screens.

Management

- Activated charcoal:
 - Avoid in somnolent patients.
- Bedside fingerstick glucose test.
- Naloxone:
 - Indicated for RR <12 when opioids are suspected.
 - Initial bolus is 0.05–0.1 mg IV or IM, doubled or repeated every minute until ventilation is restored.
 - In patients with opioid tolerance, high doses of naloxone will precipitate opioid withdrawal:
 - Administer antiemetics and help calm the patient.
 - After ~15 min the naloxone effect will diminish and the patient will begin to exhibit the opioid toxidrome again.
 - If naloxone is successful, administer a naloxone infusion at two-thirds of the total initial successful dose, administered hourly.
- IV fluids.
- Serum acetaminophen concentration should be obtained in all patients with intentional overdose.
- N-Acetylcysteine is indicated for patients with one of the following:
 - Acetaminophen concentration that plots above the treatment line on the Rumack–Matthew nomogram.
 - Elevated aminotransferases without known etiology.
 - Detectable acetaminophen concentration without known time of ingestion.
 - Acetaminophen poisoning is suspected, the ingestion occurred more than 8 h prior, and laboratory results are pending.

Debriefing plan

Plan for ~30 min for discussion

Potential questions for discussion

- What are opioids?

- What is the opioid toxidrome?
- How is naloxone administered?
- When is an appropriate time for a fingerstick glucose test to be performed?
- What are the indications to obtain an acetaminophen concentration?
- Why is the urine toxicology screen negative for opiates in this patient?
- (Optional scenario ending) When do we administer *N*-acetylcysteine to patients with suspected acetaminophen poisoning?

Selected reading

1. Nelson LS, Olsen D. Opioids. In: Nelson LS, Lewin NA, Howland MA, Hoffman RS, Goldfrank LR, Flomenbaum NE, eds. *Goldfrank's Toxicologic Emergencies*, 9th edn. New York: McGraw-Hill, 2010, pp. 559–574.
2. Aguina CT, Marques-Baptista A, Bridgeman P, Merlin MA. OxyContin abuse and overdose. *Postgrad Med* 2009;**121**(2):163–167.

Sympathomimetic overdose

Educational goals

Learning objectives

Primary:

1. Recognize clinical signs of sympathomimetic toxicity [*Medical Knowledge*].
2. Recognize life-threatening hyperthermia [*Medical Knowledge*].
3. Demonstrate the use and titration of benzodiazepines in controlling a sympathomimetic toxidrome [*Patient Care*].
4. Demonstrate the early institution of rapid cooling measures with continuous rectal temperature monitoring and cool mist/fan or ice-bath. [*Patient Care*].

Secondary:

1. Demonstrate professionalism and communication skills when consulting the intensive care unit (ICU) and working with ED nurse [*Interpersonal and Communication Skills, Professionalism*].
2. Direct proper disposition/appropriate consultation [*Systems-based Practice*].

Critical actions checklist

- ☐ Assess airway, breathing, circulation (ABCs) [*Patient Care*]
- ☐ Obtain fingerstick glucose test or administer empiric dextrose with thiamine [*Medical Knowledge*]
- ☐ Order ECG and recognize tachycardia [*Medical Knowledge*]
- ☐ Initiate proper therapy for sympathomimetic toxidrome: IV fluids, benzodiazepines, and cooling measures [*Medical Knowledge, Patient Care*]
- ☐ Call and communicate to ICU for disposition [*Interpersonal and Communication Skills, Professionalism*]

Critical actions can be changed to address the educational needs of the learner.

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin, no moulage, on a stretcher or hospital bed. Mannequin should be male.

Props: To be displayed on plasma screen/computer screen or printed out on handouts in the scenario room when asked for/return from laboratory:

- Images (see online component for Sympathomimetic Overdose, *Scenario 10.3.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG with sinus tachycardia.
 - Preliminary radiology read of normal head CT.
 - Preliminary radiology read of normal chest X-ray.
- Labs (see online component as above):
 - Complete blood count.
 - Complete metabolic panel.
 - Cardiac enzymes.
 - Pro-B natriuretic peptide.
 - Urinalysis.
 - Lactate.
 - Coagulation panel
 - Urine toxicology screen.
 - Serum toxicology.

Available in the treatment room:

- Basic airway and code cart.
- Ice bags.
- Fan.
- Cooling blanket.
- Medications (labeled bags/syringes may be used in place of actual medicine syringes or bags):
 - Ampules of sodium bicarbonate
 - IV lidocaine
 - Sedative and paralytic typically used at your institution for rapid sequence intubation.
 - Intravenous fluids (IVFs): including normal saline (NS) and 5% dextrose in water (D5W).
 - Ampules of 50% dextrose (D50).
 - IV benzodiazepine of choice (e.g. lorazepam or midazolam).

Distractor: None.

Actors:

- Paramedic(s) are able to provide information about the scene.
- Patient voice is male. Patient is moaning unintelligibly.

- ED nurse can start IVs and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed.
- Poison control available via “phone consultation.” Option: to increase difficulty you can make poison control unavailable.
- ICU physician can be available via “phone consultation.”

Case narrative

Scenario background

A 45-year-old male found unresponsive in his office. Patient works at a bank downtown. According to the paramedics, he appeared healthy when arriving to work. He had been working in his office alone for several hours when he was found collapsed on his desk with a crack pipe still in his hand. His medical history is unknown.

Background may be presented prior to the case, by EMS, or given as a triage sheet.

CC: Unresponsive.

PMH: Unknown.

Meds: Unknown.

Allergies: None.

Family Hx: Unknown.

Social Hx: Crack cocaine, otherwise unknown.

Initial scenario conditions

Patient is moaning and flailing all extremities (nurse may cue this by stating, “I need some help to control this guy!” “He’s going to fall off the bed!”).

VS: Temp 38.3 °C (100.9 °F), HR 125, RR 24, BP 197/120, O₂ sat 98% RA.

Eyes: Pupils mydriatic, equal.

Heart: Tachycardia, no murmurs.

Lungs: Equal bilaterally, clear to auscultation.

Abdomen: Bowel sounds normal.

Neurologic: Moaning unintelligibly, moving all extremities, spontaneously opens eyes.

Skin: Diaphoretic.

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners. For example, if your mannequin does not have reactive pupils you can verbally report the pupillary examination when it is requested, or if your mannequin is not capable of diaphoresis, this can be simulated by spraying the mannequin with water or glycerin spray prior to starting the scenario.

See the flow diagram in Figure 10.3 for further scenario changes described below.

Case narrative, continued

Initially a single dose of IV benzodiazepine will minimize this patient's agitation and he admits to smoking "a lot of crack" and describes a feeling of "bugs crawling under the skin." A second dose of IV benzodiazepine and cooling measures have to be initiated to prevent this patient from worsening. To make this case more difficult for senior learners, consider making the patient hypoxic after benzodiazepines are given so that he requires intubation.

After 5 min, laboratory results will return and demonstrate positive cocaine in the toxicology panel (if ordered).

If benzodiazepines are not administered, the patient will clinically worsen over 10 min until he develops a wide complex tachycardia. Benzodiazepines and bicarbonate +/- lidocaine should be administered for persistent cocaine-induced wide complex tachycardia. If defibrillation is done, the arrhythmia will not convert.

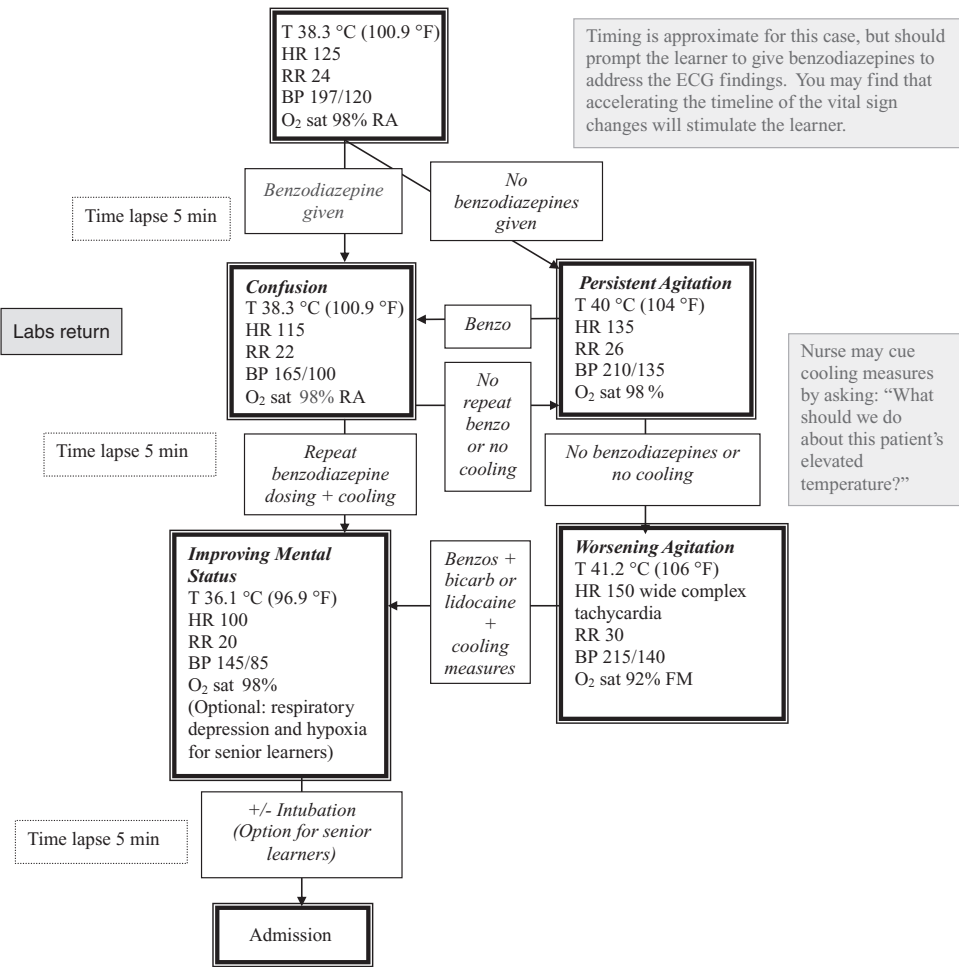


Figure 10.3 Scenario flow diagram: sympathomimetic overdose.

Instructor notes

Pathophysiology

Cocaine is a Type IA antidysrhythmic and inhibits reuptake of biogenic amines (dopamine, norepinephrine, and serotonin), causing several physiologic effects:

- Prolongs Phase 0 of cardiac depolarization by blocking fast sodium channels → ventricular tachycardia, QRS widening, Brugada pattern.
- Inhibits reuptake of biogenic amines → prolongation of dopamine, norepinephrine, and serotonin in neuromuscular junction → euphoria (sometimes paranoia or agitation) and sympathomimetic findings (increased contractility, vasoconstriction).
- Hyperthermia results from muscular heat production due to agitation and vasoconstriction.

Clinical features

- Altered mental status leading to states of euphoria, agitation, paranoia, and seizures.
- Pupils are mydriatic.
- Cardiovascular effects:
 - Sinus tachycardia.
 - Ventricular tachycardia.
 - Widened QRS.
 - Brugada pattern.
 - Elevated blood pressure.
- Elevated temperature:
 - Hyperthermia is the most common cause of death in cocaine overdose.
- Diaphoresis.

Diagnosis

- Positive cocaine in urine toxicology screen with clinical symptoms and characteristic ECG findings.

Management

- IV Benzodiazepines are first-line therapy; midazolam may be preferred because of its brief onset and duration of action (like cocaine):
 - 1–2 mg IV midazolam, repeat dose every 3–5 min if agitation continues (caution with signs of respiratory depression).
- Treat hyperthermia aggressively:
 - Intubate and paralyze (avoid succinylcholine as it competes with cocaine for plasma cholinesterase).
 - Cool with fans or ice.
 - Reduce temperature below 40.5°C within 30 min.
- Treat cocaine-associated ventricular tachycardia with drugs that compete for sodium channel binding:
 - Sodium bicarbonate is first-line therapy (1 meq/kg).
 - Lidocaine (Class IB) is second-line therapy.

Debriefing plan

Plan for ~30 min for discussion.

Potential questions for discussion

- What is cocaine and what are its mechanisms of action?
- What are the characteristic ECG findings of cocaine overdose?
- What is the general emergency management of an overdose?
- What is the specific treatment for cocaine overdose?
- What are the expected physical examination findings in cocaine overdose?
- What are potential clinical effects of cocaine overdose?

Selected reading

1. Prosser JM, Hoffman RS. Cocaine. In: Nelson LS, Lewin NA, Howland MA, Hoffman RS, Goldfrank LR, Flomenbaum NE, eds. *Goldfrank's Toxicologic Emergencies*, 9th edn. New York: McGraw-Hill, 2010, Chapter 76.
2. Haynes, JF. Medical management of adolescent drug overdose. *Adolesc Clin N Am* 2006; 17(2):353–379.

CHAPTER 11 **Pediatric emergencies**

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Neonatal resuscitation

Educational goals

Learning objectives

Primary

1. Recognize the signs of newborn distress [*Medical Knowledge*].
2. Implement the latest guidelines regarding neonatal resuscitation [*Practice-based Learning, Patient Care, Medical Knowledge*].
3. Perform airway management [*Medical Knowledge*].

Secondary

1. Demonstrate communication skills by addressing a mother's concerns while simultaneously working with the ED staff [*Interpersonal and Communication Skills*].
2. Identify and treat hypoglycemia [*Medical Knowledge, Patient Care*].

Critical actions checklist

- ☐ Suction and stimulate the infant [*Patient Care*]
- ☐ Identify hypothermia and initiate warming [*Patient Care*]
- ☐ Provide airway support [*Patient Care*]
- ☐ Obtain vascular access [*Patient Care*]
- ☐ Treat hypotension [*Patient Care, Medical Knowledge*]
- ☐ Identify and treat hypoglycemia [*Medical Knowledge, Patient Care*]
- ☐ Communicate with the parents and update them frequently [*Interpersonal Skills and Communication, Professionalism*]
- ☐ Treat bradycardia [*Patient Care, Medical Knowledge*]
- ☐ Order empiric antibiotics for sepsis [*Medical Knowledge*]

Critical actions must be updated to reflect current neonatal resuscitation guidelines. The case and critical actions can be modified to address the educational needs of the learner.

Emergency Medicine Simulation Workbook: A Tool for Bringing the Curriculum to Life, First Edition. Edited by Traci L. Thoureen and Sara B. Scott.

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Simulation set-up

Environment: Emergency Department treatment area.

Mannequins: Two infant mannequins are required. At the beginning of the case, the mother is at the side of the room holding an infant prop (a doll or a low-fidelity mannequin). A high-fidelity infant simulator is set up on a hospital stretcher, wearing a diaper and wrapped in a blanket. It is blocked from view at the beginning of the case.

Moulage is optional but can be used to mimic acrocyanosis and small amount of meconium in the mouth and nose. Examination findings can be provided verbally if moulage is not used.

Moulage can be made by mixing makeup and lubricant approved for use with the mannequin.

Props: Results can be shown on a video screen or a handout and provided when requested.

- Images: none.
- Labs (see online component for Neonatal Resuscitation, *Scenario 11.1.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - Fingerstick glucose test.
 - Point-of-care laboratory results (glucose, sodium, potassium, creatinine, hemoglobin) (optional if this type of testing is not available at your facility).

Available in the treatment room:

- Infant airway supplies and code cart.
- IV supplies.
- Intraosseous (IO) kit (option for advanced learners).
- Umbilical vein (UV) kit (option for advanced learners).
- Neonatal or infant pulse oximeter probe and cardiac monitor.
- Medications
 - 0.9% saline (NS)
 - 10% dextrose solution D10
 - Labeled IV bag with antibiotics appropriate for institution/current recommendations e.g. Vancomycin, cefotaxime

Distractor: Patient's mother (see description below).

Actors:

- Nurse is neither helpful nor obstructive.
- Mother is calm, unless the team does not address her; if the team does not keep her informed and updated, she becomes obstructive.
- Neonatal ICU physician available by telephone.

The actors' input can be modified to change the difficulty of the scenario, to prompt the learners, and/or to move the case forward.

This scenario is designed for multiple learners working as a team. It can be modified for one learner by having the mother be cooperative and IV access established by the nurse.

Case narrative

Scenario background

Nurse: "This is a homebirth baby. The mother won't let me take him to check his vital signs."

Mother: "We both need to sleep, but my midwife insisted I get my baby checked out first."

CC: Homebirth newborn.

PMH: None reported by mother.

Meds: Prenatal vitamins.

Allergies: None.

Social Hx: No tobacco, alcohol, or drugs.

ROS: Negative.

OB Hx:

- Water broke about 32 h ago.
- Due date was 1 week ago.
- First pregnancy, no problems, followed by a midwife.
- Mother does not know her testing details (Rh, Group B Strep, etc.).
- Labor lasted 14 h, fluid turned brownish towards the end.
- Delivery was 30 min ago.

Initial scenario conditions

Mother is holding her baby and allows him to be taken from her if an ED staff member explains why this is important. If this explanation is not given, the mother refuses to let the team have the baby.

Once the baby is released from the arms of the mother, the case moves from the infant prop to the simulator on a gurney.

Initial examination shows a sleeping baby.

VS: Temp. 33.8°C (92.8°F) axillary or rectal (only if asked), HR 62, RR 22, BP and O₂ sat cannot be obtained.

Head: Flat fontanelle, no obvious hematomas.

Nose/oropharynx: Brownish secretions in mouth and nose, weak suck.

Lungs: Bilateral rhonchi.

Cardiac: Regular rate and rhythm.

Abdomen: Normal bowel sounds, soft.

Extremities: Cool, acrocyanosis.

Pulses: Symmetric brachial and femoral pulses, delayed capillary refill +4.

Skin: Pale, cool, no lesions.

Neuro: Floppy tone, minimal suck, no cry.

Findings that are not portrayed on the mannequin can be reported verbally.

See the flow diagram in Figure 11.1 for further scenario details described below.

Case narrative, continued

The team must get the baby on to the hospital stretcher to begin the scenario.

The first 5 min involve suctioning, stimulation, and warming, followed by PPV and oxygen. The vital signs mildly improve but hypoxia persists so the team must proceed with intubation. The nurse can prompt them as needed. The mother is cooperative if she is kept informed; otherwise, she becomes obstructive if she is not updated before her baby is intubated.

By 5 min, if the baby has not been intubated and/or warmed, his vital signs decline towards bradycardia. By 8 min, PEA arrest will occur if not intubated or warmed. This decline continues until appropriate treatments are provided or the case ends.

Following intubation/warming, vascular access is needed. For student learners, the nurse obtains IV access when it is ordered. Advanced learners must obtain vascular access by an IO route or low-lying UV.

Learners should order a fluid bolus and bedside measurement of glucose. Advanced learners should be expected to also administer empiric antibiotics, and order further workup.

Results of a bedside glucose test and other point-of-care laboratory results can be provided once they are ordered. Learners should recognize and treat hypoglycemia, although this will not change the infant's vital signs.

To further challenge advanced learners after vascular access is obtained, the baby's HR drops to <60 bpm, requiring chest compressions and epinephrine to stabilize him.

The case ends after the learners present the case to the NICU attending and counsel the mother.

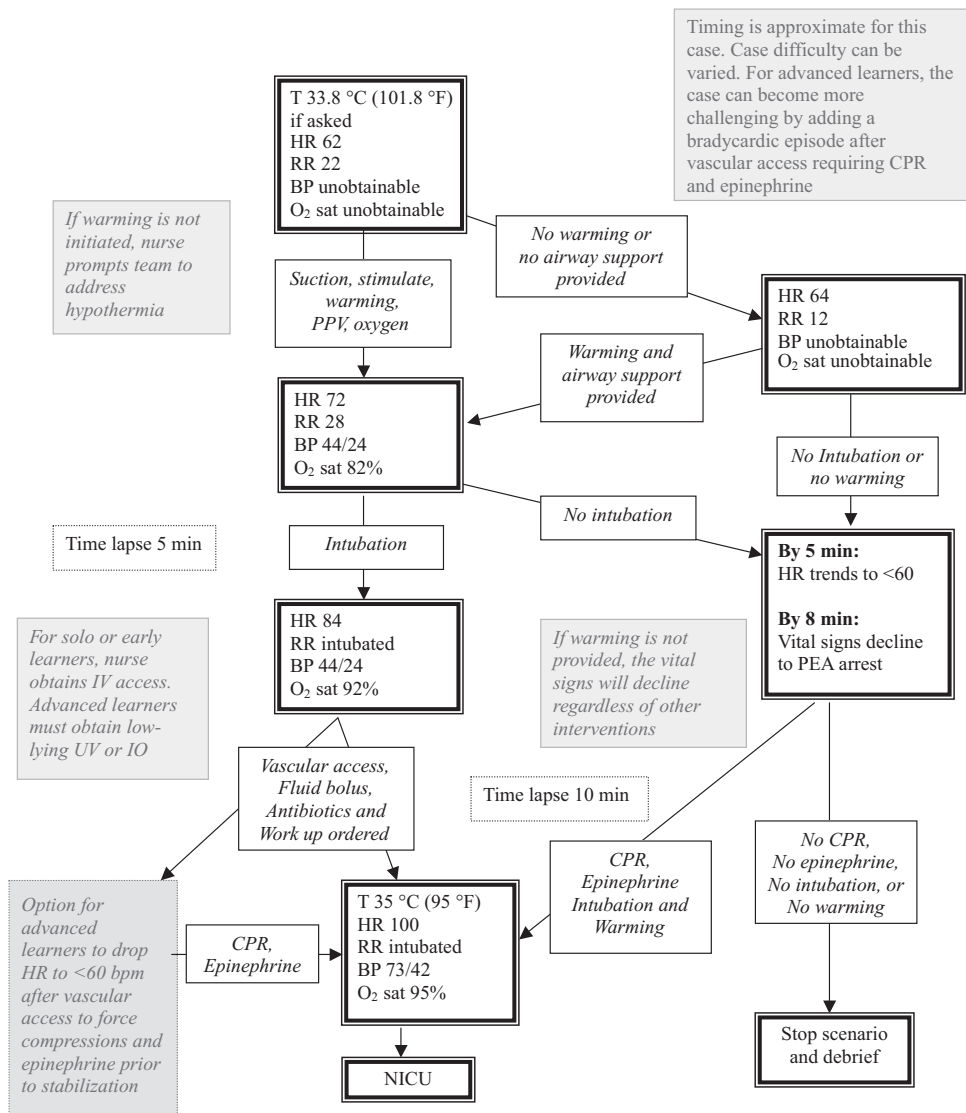


Figure 11.1 Scenario flow diagram: neonatal resuscitation.

Instructor notes

Background

- Home births are associated with fewer medical interventions and a threefold increase in the neonatal mortality rate.¹
- Postpartum neonatal distress may be caused by prematurity, hypoventilation, hypoxia, meconium aspiration, metabolic dysfunction, trauma, shock, peripartum drug effects, neonatal drug withdrawal, and congenital abnormalities.

Diagnosis

- Neonatal distress
 - Primarily clinical, based on simultaneous assessment of heart rate and respirations with pulse oximetry.

Clinical features of neonatal distress

- Bradycardia.
- Persistent hypoxia and cyanosis.
- Apnea.
- Hypothermia.
- Hypoglycemia.
- Hypotension.
- Hypotonia.

Management

- Current neonatal resuscitation guidelines should be followed:²
 - Initial stabilization: dry and warm, position, assess the airway, stimulate to breathe.
 - Ventilate.
 - Compressions: 3:1 compressions/ventilations, two-finger technique.
 - Medications: epinephrine.
- It is critical to stabilize the neonate while managing parental concerns.
- Treat hypothermia ($<36.5^{\circ}\text{C}$) via external rewarming:
 - If it is not treated, the vital signs remain depressed despite other interventions.
 - Check the infant's temperature frequently to avoid overheating.
- Heart rate response correlates with the effectiveness of resuscitation.
- Monitor the blood glucose concentration frequently.
- Give empiric antibiotics to treat presumed sepsis.

Debriefing plan

Allow ~30 min for discussion.

Potential questions for discussion

- What are the clinical signs of neonatal distress?
- What are the potential contributing factors in postpartum neonatal distress?

- What history details (prenatal, labor and delivery) are important?
- Define neonatal hypothermia and its forms of treatment.

Selected reading

1. Wax JR, Lucas FL, Lamont M, *et al.* Maternal and newborn outcomes in planned home birth vs planned hospital births: a meta-analysis. *Am J Obstet Gynecol* 2010;**203**(3):243.e1–243.e8.
2. Perlman JM, Wyllie J, Kattwinkel J, *et al.*; on behalf of the Neonatal Resuscitation Chapter Collaborators. Part 11: Neonatal resuscitation: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. *Circulation* 2010;**122**(Suppl 2):S516–S538.

Bronchiolitis

Educational goals

Learning objectives

Primary:

1. Recognize the clinical signs of bronchiolitis [*Medical Knowledge, Patient Care*].
2. Demonstrate appropriate supportive treatment for the wheezing infant [*Medical Knowledge, Patient Care*].
3. Anticipate and manage apnea and respiratory failure in an infant with bronchiolitis [*Medical Knowledge, Patient Care*].

Secondary:

1. Choose adjunctive therapies for management of bronchiolitis [*Medical Knowledge, Practice-based Learning*].
2. Explain the patient's condition to a parent [*Interpersonal and Communication Skills, Professionalism*].
3. Demonstrate proper isolation precautions [*Systems-based Practice*].

Critical actions checklist

Review and update critical actions regularly to reflect new developments in the literature.

- ☐ Assess and re-assess airway, breathing, circulation [*Patient Care*]
- ☐ Apply supplemental oxygen [*Patient Care*]
- ☐ Suction nasopharynx [*Patient Care*]
- ☐ Discuss patient's clinical status with the parent [*Interpersonal and Communication Skills, Professionalism*]
- ☐ Put on gloves, mask, and eye protection for droplet precautions [*Systems-based Practice*]
- ☐ Ventilate with bag valve-mask when patient becomes apneic [*Patient Care*]
- ☐ Select appropriately sized intubation equipment for infant and intubate [*Medical Knowledge, Patient Care*]

Learning objectives and critical actions can be adapted to different learners. For example, student learners may meet only the first two learning objectives and the case will not proceed towards apnea, whereas for more advanced learners, the case is not complete until the infant's trachea is intubated.

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Infant simulator mannequin, no moulage, on stretcher bundled up, with pacifier in mouth

Props:

- Images (see the online component for Bronchiolitis, *Scenario 11.2.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - Chest X-ray showing normal cardiac silhouette, over-expanded lung fields, and segmental atelectasis (optional).

A chest X-ray is not routinely recommended for infants with bronchiolitis, but if it is the standard of care in your institution you should provide it. If the child is intubated, a post-intubation chest X-ray can be shown or can be noted as having good placement of the endotracheal tube by radiology.

- Labs (see online component as above):
 - Direct fluorescent antigen test for respiratory syncytial virus (RSV) (or equivalent as used in your institution).

Available in room:

- Basic pediatric airway and code cart.
- Medications (labeled bags/syringes may be used in place of actual medicine syringes or bags):
 - IVF [0.9% normal saline (NS) and 5% dextrose in water (D5W)].
 - Albuterol.
 - Racemic epinephrine.
 - 3% sodium chloride for nebulization.
- Nebulization device.

Distractor: None.

Actors:

- Parent can give a basic history.
- ED nurse can start IVs and may cue learners if needed.
- Respiratory therapist to start nebulization treatments and help with selection of airway equipment.

Depending on learning needs, the respiratory therapist can be omitted from the actor list, leaving responsibility for assembly of equipment and administration of nebulizing treatment as an expected action of the learner.

- Pediatric ICU physician can be available via “phone consultation.”

Case narrative

Scenario background

A 3-month-old male infant presents with a 2 day history of rhinorrhea, decreased feeding, and now “funny breathing” since this morning. Mother says he is breathing faster than usual.

Background may be presented prior to the case or by a parent or conveyed on a triage sheet.

CC: Respiratory distress.

PMH: Born at term, uncomplicated pregnancy, spontaneous normal vaginal delivery.

Received hepatitis B vaccination at birth; no other vaccinations have been given yet.

Birth weight, 3.6 kg.

Meds: Mother gave the infant acetaminophen drops this morning, quantity unknown (“what it said to give on the bottle”).

Allergies: None.

Family Hx: Father has asthma.

Social Hx: Lives with both parents and two older siblings, both of whom had a “cold” recently.

Initial scenario conditions

Sleepy male infant with an abdominal breathing pattern and deep retractions.

VS: Temp. 37.8 °C (100 °F), HR 162, RR 68, BP 76/42, O₂ sat 88% RA.

Weight: 6 kg.

Nose: Copious secretions. Note: this may be moulaged or prompted by the nurse.

Heart: Tachycardia, no murmurs.

Lungs: Tachypnea with mild grunting, coarse breath sounds with wheezes throughout, prolonged expiratory phase.

Abdomen: Soft, no hepatomegaly.

Perfusion: Palpable pulses, warm with brisk capillary refill.

Physical examination findings that are not available on your mannequin can be reported verbally. Spontaneously describe audible and visible cues that are evident, but await actions or questions from learners for those that are not readily noticeable; for example, do not report retractions until the patient’s chest is exposed and discuss normal liver size only if the abdomen is palpated.

See the flow diagram in Figure 11.2 for further scenario changes described below.

Case narrative, continued

Student learners should suction the nasopharynx and consider oxygen supplementation before rushing into bag-mask ventilation and/or intubation. Additionally, they may administer various nebulization treatments such as albuterol, racemic epinephrine, or 3% saline and steroids, which are good discussion points for debriefing. Recognizing the need for admission is another end-point for early learners.

For advanced learners, the case will progress to a brief apnea episode, with resulting hypoxia and bradycardia. Brief apneic spells (lasting 10–15 s, as typically seen in bronchiolitic infants) often go unnoticed by learners. You can make spells more obvious by prolonging them. If learners provide bag-mask ventilation or intubation, the child recovers. If there is a delay in advanced airway intervention, asystole and complete cardiopulmonary arrest occur and CPR is needed.

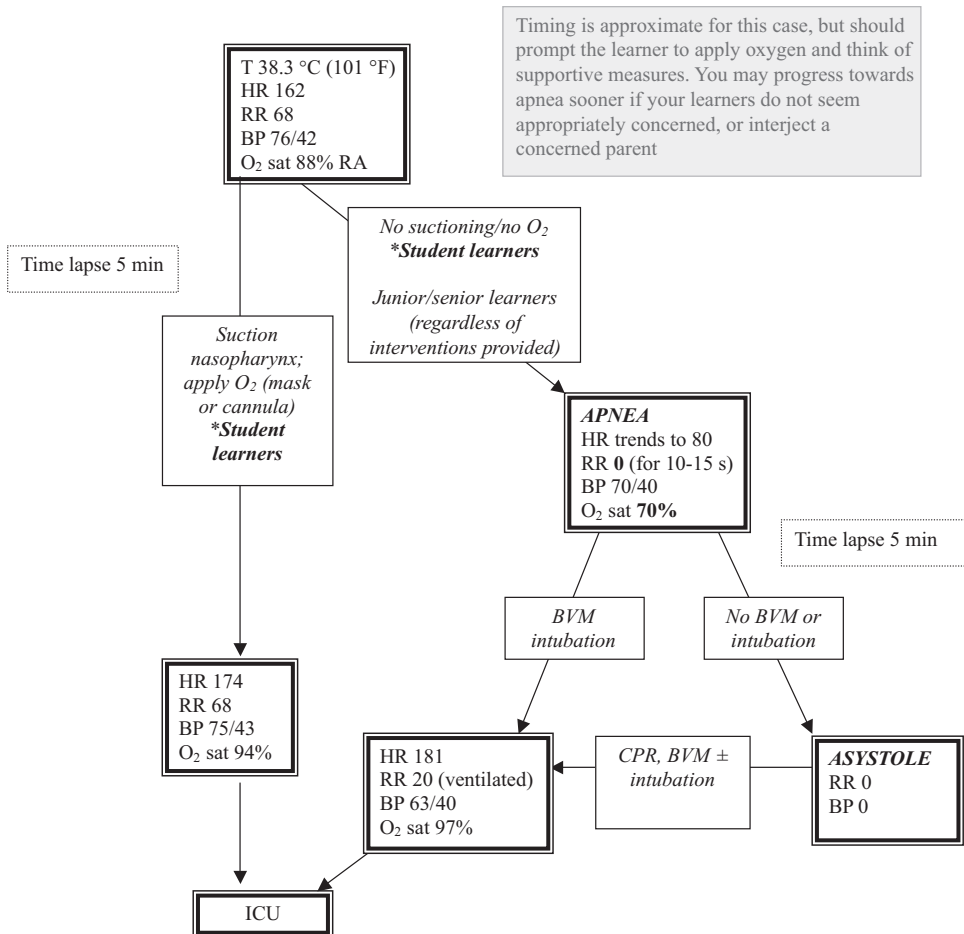


Figure 11.2 Scenario flow diagram: bronchiolitis.

Instructor notes

Pathophysiology

Bronchiolitis is acute inflammation of the distal bronchioli caused by viral infection. The most common causes are as follows:¹

- Respiratory syncytial virus (RSV).
- Human metapneumovirus.
- Parainfluenza.
- Influenza.

All are contagious and require infectious precautions, including droplet precautions for RSV and influenza.

Clinical features

- Symptoms: mild rhinorrhea to severe respiratory distress with tachypnea, retractions, grunting, and hypoxia.
- Auscultation: fine crackles and/or expiratory wheezes.
- Chest X-ray: overinflated lung fields, peribronchial cuffing, segmental atelectasis.
- Disease peaks in severity typically at day 5 of illness.
- Apnea (in 3–10%; most common in infants younger than 1 month of age with RSV)¹ can be obstructive (due to secretions), central (unclear mechanism), or both.

Diagnosis

- Primarily a clinical diagnosis.
- Direct fluorescent antibody or PCR testing can identify a specific etiologic agent, but false negatives are common.
- Chest X-ray is not required.
- Differential diagnosis: pneumonia, pulmonary edema, asthma/reactive airway disease (in older children).

Management

- Only supportive: clear secretions, supplemental oxygen.
- Intubation is typically avoided if possible:
 - Positive-pressure ventilation may worsen air trapping/mucus plugging and result in iatrogenic damage (pneumothorax).
 - Administration of oxygen via high-flow nasal cannula or continuous positive airway pressure (CPAP) are safe alternatives.
- Limited evidence² exists for the following:
 - Bronchodilator therapy: the American Academy of Pediatrics does not recommend routine treatment with bronchodilators.³ A trial dose of albuterol or racemic epinephrine is recommended, but therapy should be discontinued if it has no effect.
 - Hypertonic saline nebulization: 3% saline nebulization may shorten hospital stay.⁴
 - Corticosteroids, inhaled or systemic: no conclusive evidence/not recommended.

Debriefing plan

Allow ~30 min for discussion.

Potential questions for discussion

- What causes bronchiolitis?
- What are the risk factors for severe disease?
- What are the risk factors for apnea?
- When is the peak of illness?
- What supportive measurements can be attempted?
- How can the transmission of disease be prevented?
- Why should intubation be avoided?
- How should you explain the disease to the parents?

Selected reading

1. Zorc JJ, Breese Hall C. Bronchiolitis: recent evidence on diagnosis and management. *Pediatrics* 2010;**125**:342–349.
2. Petruzella FD, Gorelick MH. Current therapies in bronchiolitis. *Pediatr Emerg Care* 2010;**26**:302–311.
3. American Academy of Pediatrics. Clinical practice guideline: diagnosis and management of bronchiolitis. *Pediatrics* 2006;**118**:1774–1793.
4. Zhang L, Mendoza-Sassi RA, Wainwright C, Klassen TP. Nebulized hypertonic saline solution for acute bronchiolitis in infants. *Cochrane Database Syst Rev* 2008;(4):CD006458.

Seizure

Educational goals

Learning objectives

Primary:

1. Recognize seizure activity as a medical emergency [*Medical Knowledge, Patient Care*].
2. Choose appropriate first-line medications to treat new-onset seizures in infants [*Medical Knowledge, Patient Care*].
3. Recognize hyponatremia as a potential cause of seizures [*Medical Knowledge*].

Secondary:

1. Generate differential diagnosis for new-onset seizures in infants [*Medical Knowledge*].
2. Anticipate and manage benzodiazepine-induced respiratory depression [*Medical Knowledge, Patient Care*].
3. Coordinate subsequent work-up and care with other services [radiology, neurology, pediatric intensive care unit (PICU)] [*Interpersonal and Communication Skills, Systems-based Practice*].

Critical actions checklist

- ☐ Assess airway, breathing, circulation (ABCs) [*Patient Care*]
- ☐ Administer benzodiazepine [*Medical Knowledge, Patient Care*]
- ☐ Check fingerstick glucose and serum electrolytes [*Medical Knowledge, Patient Care*]
- ☐ Administer 0.9% or 3% saline [*Patient Care*]
- ☐ Obtain neurology consultation and coordinate further workup and disposition [*Interpersonal and Communication Skills, Systems-based Practice*]
- ☐ Start bag-mask ventilation when patient develops respiratory compromise [*Patient Care*]
- ☐ Select appropriate intubation equipment for an infant [*Medical Knowledge*]
- ☐ Intubate infant [*Patient Care*]

Learning objectives and critical actions can be adapted to different learners. For example, early learners might be expected to meet only the first two learning objectives and the case does not need to progress towards respiratory depression; for more advanced learners, the case is complete after the infant is intubated.

Simulation set-up

Environment: Emergency department treatment area.

Mannequin: Infant or neonatal simulator mannequin, no moulage, on a stretcher.

If your mannequin does not have functionality to have a seizure, you could use a vibrating toy under the mattress to simulate one.

Props: To be displayed on plasma screen/computer screen or printed on handouts that are distributed when the participants ask for results:

- Images: none.
- Labs (see online component for Seizure, *Scenario 11.3.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - Complete blood count.
 - Basic metabolic panel.
 - Fingerstick glucose test.
 - Urinalysis.

Available in room:

- Basic pediatric airway and code cart.
- Medications (labeled bags/syringes may be used in place of actual medicine syringes or bags):
 - IVF [0.9% normal saline (NS) and 5% dextrose in water (D5W)].
 - IV benzodiazepine: diazepam, lorazepam, and/or midazolam (based on your institution's treatment protocol).
 - Labeled 20 ml syringe with 3% saline solution
- Broselow tape.

Distractor: None.

Actors:

- Parent can give a basic history.
- EMS can give history of transport.
- ED nurse can start IVs and may cue learners if needed.
- Neurologist and PICU physician can be available for "phone consultation."

Case narrative

Scenario background

A 10-day-old female infant is brought in by ambulance after her mother called 911 because she found the infant “having a fit” in her crib. The infant has had emesis for 2 days and decreased feeding since yesterday.

EMS transports the patient to the ED. For student learners, they will state that they did not have time to give any medications prior to arrival. For junior and senior learners, they will state that rectal diazepam was given.

CC: Seizure.

PMH: Born at 36 weeks’ gestation, spontaneous normal vaginal delivery. Infant spits up with feeds, but mother has been diluting the formula with extra water, which seems to help. Received first hepatitis B vaccination; no other vaccinations have been given yet. Birth weight, 2.9 kg; weight was also 2.9 kg at 1 week follow-up visit with pediatrician.

Meds: None.

Allergies: None.

Family Hx: Non-contributory.

Social Hx: Lives with parents.

Initial scenario conditions

Patient exhibits generalized tonic-clonic seizures.

VS: Temp. 37.2 °C (99 °F), HR 148, RR 43, BP 73/39, O₂ sat 95% RA.

Weight: 3.1 kg (stated by nurse if asked).

Fingerstick glucose: 110.

Head: Head atraumatic, anterior fontanel slightly sunken.

Eyes: Pupils equally reactive to light.

Mouth: Mucous membranes dry.

Heart: Moderate tachycardia, regular rhythm, no murmurs.

Lungs: Adequate respiratory effort; equal, clear breath sounds.

Perfusion: Good pulses; warm, brisk capillary refill.

Physical examination findings that are not available on your mannequin can be reported verbally. Spontaneously describe audible and visible cues that are evident, but await actions or questions from learners for those that are not readily noticeable; for example, do not comment on the fontanel until the learner palpates the head or asks about it.

See the flow diagram in Figure 11.3 for further scenario changes described below.

Case narrative, continued

For student learners, the case can stop after IV or rectal administration of benzodiazepines without further complications. The debriefing can focus on recognition of seizures, their possible causes, secondary precautions, and choice of first-line medications.

For junior and senior learners, the seizure should continue despite additional IV benzodiazepines and the case can be made more complex by adding respiratory depression, requiring intervention, in response to the benzodiazepines. In this scenario, only appropriate treatment of hyponatremia will stop the seizure.

Learners may administer a normal saline bolus without recognizing hyponatremia as the cause for the seizure. Once an appropriate amount of sodium (4 mL/kg of 3% NaCl solution) has been administered, the instructor can stop the seizure but should address the cause in the debriefing.

If learners administer too much sodium, potential consequences should also be addressed during the debriefing.

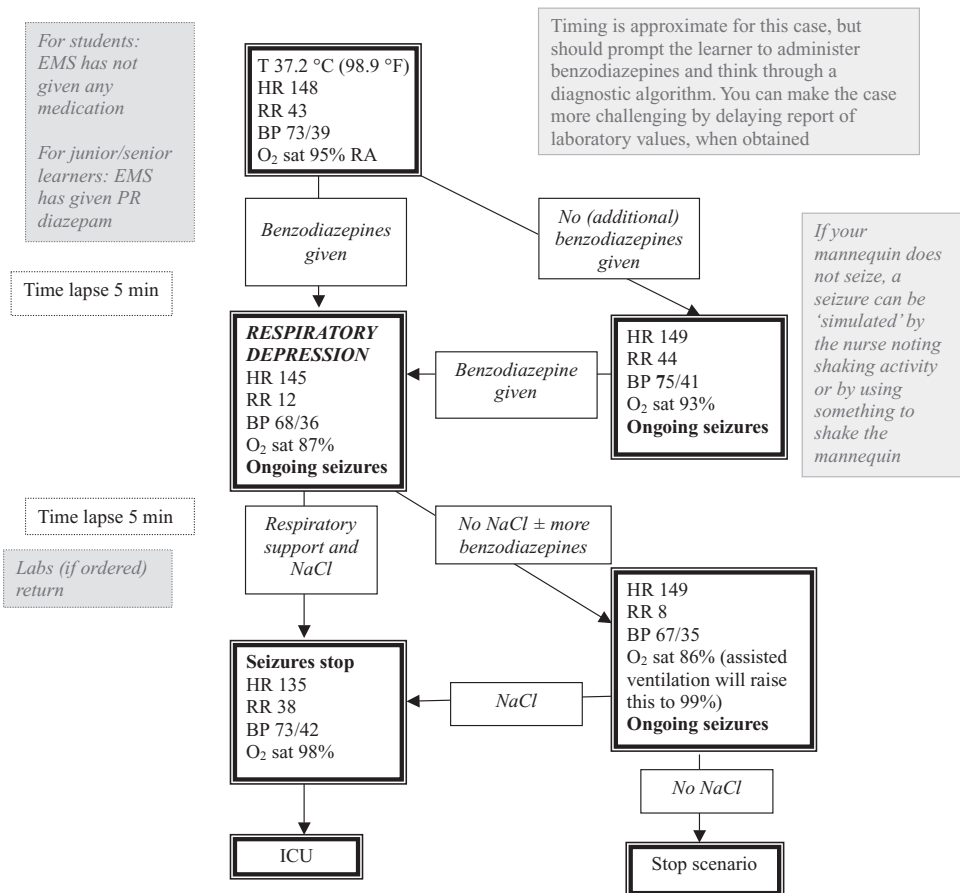


Figure 11.3 Scenario flow diagram: seizure.

Instructor notes

Pathophysiology

Differential diagnosis for seizures in neonates and infants:¹

- Metabolic: hyponatremia, hypoglycemia, hypocalcemia.
- Intracranial infection.
- Intracranial hemorrhage.
- Hypoxic ischemic injury.
- Congenital abnormalities of the brain.

In toddlers/school-age children, febrile seizures are most common.

Clinical features

- Tonic, clonic, tonic-clonic, or myoclonic movements. Subtle seizures can occur in neonates (lip smacking, eye deviation).
- Status epilepticus = seizure activity for >30 min or repeated seizures without full recovery in between.²

Diagnosis

- Seizures are generally easily diagnosed by trained providers.
- EEG monitoring can be helpful if the diagnosis is unclear or the patient is chemically paralyzed.
- Workup for new-onset seizures in children is controversial. Practice parameters recommend the following:^{1,2}
 - Full workup and neurology consultation in infants <6 months of age.^{1,2}
 - No further workup for febrile seizures, unless they are complex.
 - Complete blood count and electrolytes in non-febrile first seizures.
 - Careful history and physical examination: congenital abnormalities, evidence of non-accidental trauma.
 - Neuroimaging: children with focal findings, persistently altered mental status, or unclear cause of seizure; postpone until after resolution of status epilepticus/stabilization.

Management

- Seizures are a medical emergency.
- Protect the patient from injury and protect the airway.
- Choice of medications depends on setting, the presence of IV access, and the patient's age. Commonly used drugs and doses are as follows:¹
 - Diazepam, 0.3–0.5 mg/kg PR or IV.
 - Lorazepam: 0.05–0.10 mg/kg IV.
 - Midazolam: 0.05–0.10 mg/kg IV (can also be given IM, intranasally, or PR).
 - Phenobarbital loading dose: 20 mg/kg IV.
 - Fosphenytoin or phenytoin: 15–30 mg/kg IV.
 - Valproate: 20 mg/kg IV.
 - Levetiracetam: 50 mg/kg IV.

- Side effects and other concerns:
 - Benzodiazepines and barbiturates: respiratory depression and hypotension.
 - Fosphenytoin: unreliable protein binding in infants; not first choice for patients under 1 month of age.
 - Levetiracetam: commonly used second-line agent after benzodiazepine; limited data in children.
- After administration of anti-epileptic agents, non-convulsive status can persist.
- Neuromuscular blocking agents can mask ongoing seizure activity.
- Seizures resulting from hyponatremia and hypoglycemia respond poorly to anything other than correction of the underlying abnormality:
 - In hyponatremia, 0.9% or 3% NaCl can be administered. After the initial bolus to raise the serum sodium level above the seizure threshold (the recommended dose is 4 ml/kg of 3% NaCl solution), further administration should be gradual (no more than 8 mmol/L/day increase) to prevent central pontine myelinolysis. 0.9% NaCl solution has 0.153 mEq/mL as compared to 0.3% NaCl solution which has 0.513 mEq/mL, so approximately three times the volume of 0.9% NaCl would be required to stop the seizure.

Debriefing plan

Allow ~30 min for discussion.

Potential questions for discussion

- What are the likely causes of seizures in an infant?
- What are first-line treatment options in infants?
- What are first-line treatment options in older children?
- What are the side effects of benzodiazepines?
- What is the downside of using neuromuscular blocking agents when intubating a seizing patient?
- Would you change your plan for workup if the patient were febrile?
- Would you change your plan for workup if the patient were older (e.g. 5 years of age)?

Selected reading

1. Shariëff GQ, Hendry PL. Afebrile pediatric seizures. *Emerg Med Clin North Am* 2011;**29**:95–108.
2. Riviello JJ, Ashwal S, Hirtz D, *et al.* Practice parameter: diagnostic assessment of the child with status epilepticus. *Neurology* 2006;**67**:1542–1550.

Non-accidental trauma

Educational goals

Learning objectives

Primary:

1. Order an appropriate workup for altered level of consciousness [*Medical Knowledge, Practice-based Learning*].
2. Develop a broad differential diagnosis list for altered level of consciousness [*Medical Knowledge*].

Secondary:

1. Recognize the signs of non-accidental trauma [*Medical Knowledge*].
2. Demonstrate communication skills with caregivers and consultants regarding the suspicion of non-accidental trauma [*Interpersonal and Communication Skills*].

Critical actions checklist

- ☐ Perform primary trauma survey [*Patient Care, Medical Knowledge*]
- ☐ Obtain bedside glucose testing [*Medical Knowledge, Patient Care*]
- ☐ Order the workup for altered level of consciousness [*Medical Knowledge*]
- ☐ Educate mother about the necessity of obtaining bloodwork and radiologic testing [*Interpersonal and Communication Skills, Professionalism*]
- ☐ Perform airway and breathing support [*Patient Care*]
- ☐ Identify radiologic findings indicative of non-accidental trauma [*Medical Knowledge*]
- ☐ Communicate with mother regarding the concern about non-accidental trauma [*Interpersonal and Communication Skills, Professionalism*]
- ☐ Present case to the PICU for final disposition [*Interpersonal and Communication Skills*]

The case and critical actions can be modified to address the educational needs of the learner.

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Infant simulator mannequin, fully dressed, wearing a diaper. Moulage is on bilateral upper arm with small blue circles to mimic bruises from shaking. Moulage is also on the midline of the upper back with yellowish brown large marks to mimic older slap marks. The location of the bruises is not obvious unless the child is undressed and rolled.

Props: To be displayed on plasma screen/computer screen or printed on handouts that are distributed when the participants ask for:

- Images (see online component for Non-accidental Trauma, *Scenario 11.4.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - Chest X-ray – preliminary radiology reading (image reproduced courtesy of Rady Children’s Hospital, San Diego, CA).
 - CT scan brain – preliminary radiology reading (image reproduced courtesy of Rady Children’s Hospital, San Diego, CA).
- Labs (see online component above):
 - Bedside glucose measurement.
 - Point-of-care labs (glucose, sodium, potassium, creatinine, hemoglobin) (optional if your facility does not have these).

Available in room:

- Basic pediatric airway and code cart.
- Medications (labeled bags/syringes may be used in place of actual medicine syringes or bags):
 - IV benzodiazepine of choice

Distractor: Patient’s mother (see below).

Actors:

- Mother is very concerned about and protective of her baby. She does not want to cause the baby pain (IV line, laboratory tests) or radiation exposure (imaging). Mother is agreeable to a workup once the team educates her. If she is dismissed, the mother tries to take her baby home and plans to see the pediatrician in the morning.
- Nurse may prompt learners as needed.
- PICU physician is available via “phone consultation.”

Case narrative

Scenario background

Mother arrives with her 4½-month-old baby girl, who has been sleeping for 6 h instead of her usual 2 h nap. The mother became concerned when she returned from work, heard “funny” breathing, and couldn’t wake up her baby. The nanny was with the baby all day, did not report anything unusual before she left, and is not answering her mobile phone.

CC: “My baby won’t wake up!”

ROS: The baby has been fussy a lot for the past 2 weeks. The pediatrician said this was due to teething and recent 4 month shots. No other recent symptoms, no fevers, no sick contacts.

PMH: Full term, first born, normal perinatal history. Positive for delay in developmental milestones. Immunizations are up to date.

Meds: None.

Allergies: None.

Social Hx: No smoking, no drugs, occasional alcohol. The mother works full time. A nanny provides childcare on weekdays. The mother’s boyfriend, who is not the baby’s father, often helps with childcare.

Initial scenario conditions

The baby is sleeping.

VS: Temp. 36.2 °C (97.2 °F) (provided only if requested), HR 115, RR 32, BP 85/55, O₂ sat 93% RA.

Weight: 6.5 kg

Head: Atraumatic, full fontanelle.

Eyes: Pupils equal and reactive bilaterally.

Ears: Cerumen obstructing bilaterally.

Mouth: Moist, weak gag.

Neck: Supple.

Lungs: Clear.

Heart: Regular rate and rhythm.

Abdomen: Soft, normoactive bowel sounds; no pain to palpation.

Neurologic: Difficult to arouse, whimpers with tactile stimuli, no eye opening, moves all extremities to pain, decreased tone.

Skin: Various stages of bruising on arms and upper back (the learner must undress and roll the child to see these).

Pulses: Symmetric +1 pulses.

Physical examination findings that are not available on your mannequin can be reported verbally if requested by learners.

See the flow diagram in Figure 11.4 for further scenario changes described below.

Case narrative, continued

The team should perform a primary survey, order workup for altered level of consciousness, and educate the mother about the need for testing. If the team does anything to her baby before addressing her, she becomes obstructive. After 5 min, the patient has signs of respiratory decline requiring airway control and intubation.

When imaging is ordered, the mother requires counseling about radiation exposure. She remains cooperative when kept informed by the team.

After 8 min, any ordered labs and imaging results return. If a brain CT has not been done or intubation has not been performed by this time, the baby has a brief seizure 1 min.

The scenario ends when appropriate information is presented to the PICU regarding the infant's injuries and clinical status.

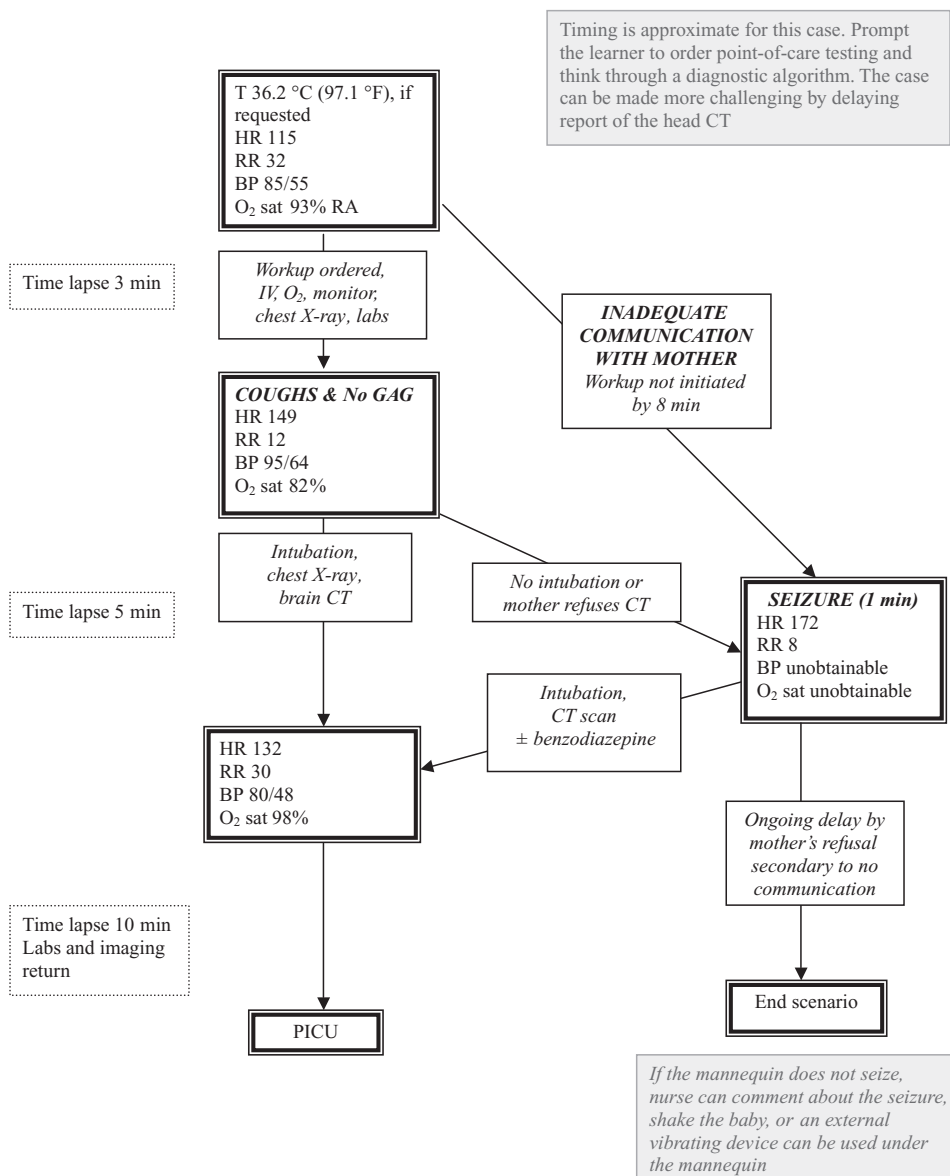


Figure 11.4 Scenario flow diagram: non-accidental trauma.

Instructor notes

Pathophysiology

An altered level of consciousness in an infant has a long list of metabolic, infectious, hematologic, neurologic, traumatic, respiratory, cardiac, congenital, and toxicologic causes.

Clinical features

Non-accidental trauma is a form of child abuse resulting in physical injury.^{1,2}

- It is often associated with additional forms of abuse (toxins, malnourishment, sexual, etc.).
- Very high risk of recurrence and death.
- Children subjected to non-accidental trauma commonly have underlying acute or chronic medical issues and developmental conditions that might be unrecognized or untreated.
- The caregiver who brings the abused child to medical attention is typically not the perpetrator and frequently is also a victim.

Diagnosis

- Suspect child abuse when any of the following conditions is seen:
 - An unexplained change in mental status or physical condition.
 - Injuries not consistent with history.
 - Injuries not appropriate for age.
 - Delayed medical care.
 - Significant injury (acute or previous) identified by radiologic studies, not reported in the history.
 - Inconsistent history.

Management

- Perform initial trauma management.
- Order the appropriate broad workup for an infant with altered level of consciousness.
- Non-judgmental communication is needed when abuse is suspected:
 - Describe objective findings.
 - Avoid speculation or bias.
- Educate the parent about the need for testing.
- Any child with suspected abuse must be removed from the dangerous setting.
- All states in the United States require mandatory reporting of suspected child abuse:
 - Only a reasonable suspicion is needed.
 - Law provides immunity from civil or criminal liability for good-faith reporting.

Debriefing plan

Allow ~30 min for discussion.

Potential questions for discussion

- What is the differential diagnoses and ED workup for this infant with an altered level of consciousness?
- What common findings suggest abuse?
- When should the provider report a suspicion of child abuse?
- What is the proper ED disposition of a child suspected of having non-accidental trauma?

Selected reading

1. Christian CW, Block R; Committee on Child Abuse and Neglect; American Academy of Pediatrics. Abusive head trauma in infants and children. *Pediatrics* 2009;**123**(5):1409–1411.
2. National Criminal Justice Reference Service, Office of Justice, US Department of Justice. *Recognizing When a Child's Injury or Illness is Caused by Abuse*. Available at www.ncjrs.gov/html/ojjdp/portable%5Fguides/abuse%5F02/ (last accessed December 1, 2011).

CHAPTER 12 **Medical error/interpersonal communication**

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Doctor–patient communication

Educational goals

Learning objectives

Primary:

1. Demonstrate professionalism and teaching skills in communication with patients and their families [*Interpersonal and Communication Skills, Professionalism*].
2. Demonstrate knowledge of proper workup and disposition for an adult with a first-time seizure [*Medical Knowledge, Patient Care*].

Secondary:

1. Develop and implement a plan for outpatient care [*Systems-based Practice*].
2. Obtain pertinent information to continue patient care when receiving sign-out of a patient [*Patient Care, Interpersonal and Communication Skills*].

Critical actions checklist

- ☐ Facilitate expedient outpatient follow-up for a patient [*Systems-based Practice*]
- ☐ Educate the patient about what to do if symptoms return or another event occurs [*Interpersonal and Communication Skills, Systems-based Practice*]
- ☐ Address primary concerns of the patient and his/her spouse and involve them in the decision-making process [*Interpersonal and Communication Skills*]

Simulation Setup

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin on a stretcher or hospital bed. The mannequin can be male or female. Moulage on tongue to replicate tongue biting consists of water-based purple and dark-blue paint in a 50:50 mixture applied along the lateral edges of the tongue, with small amounts on the corresponding teeth. A peripheral IV line is in place and the mannequin is on the cardiac monitor.

This scenario can be run using a standardized patient (SP) instead of a mannequin.

Props: To be displayed on a plasma screen/computer screen or printed on handouts to be distributed in the scenario room when the participants ask for them or when they are returned from the laboratory:

- Images (see the online component for Doctor–Patient Communication, *Scenario 12.1.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - ECG showing sinus tachycardia.
 - Radiology report of normal head CT scan without contrast.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Urinalysis.

Laboratory tests may or may not be incorporated into the scenario, depending on the available resources.

Available in the treatment room (optional):

- IVF [liter bags of 0.9% normal saline (NS) and lactated ringers (LR)].
- Cardiac monitor and leads.

Distractor: None.

Actors:

- The patient is pushy and worried about a seizure disorder. He/she is concerned about the implications for the rest of his/her life. He/she has a relative who experienced one seizure and had an EEG, and now that relative takes seizure medicines and cannot drive any longer.
- The resident physician is at the end of his/her shift and is tired and eager to leave. He/she gives this minimal sign-out report:

“I initially saw the patient 2 h ago. The patient’s initial neurologic examination was normal and there have not been any changes. I suspect a generalized seizure but the

workup so far has been unremarkable. A radiologist's reading of a head CT is the only study still pending."

The resident is apologetic about signing this out, but he/she cannot wait for the CT reading to be returned to the ED.

- The patient's spouse witnessed the event and can give additional history. He/she should act very pushy, demanding that her spouse be admitted, that an electroencephalogram (EEG) be performed, and that an anticonvulsant be given.
- The neurology office secretary is available by telephone. She can schedule an EEG for 2 weeks in the future.

Case narrative**Scenario background**

The history is provided by the off-going resident and can include a brief synopsis of the patient, unless the learner asks for a more detailed account (provided below).

A 52-year-old patient was watching TV with his/her spouse 4 h ago, when he/she suddenly became unresponsive with whole-body jerking. The spouse, who witnessed the whole event, said the patient's eyes had rolled back and he/she would not answer when repeatedly asked what was wrong. After the episode, which lasted about 3 min, the patient began to ask questions about what had happened, as if waking up from a deep sleep. The patient has no memory of the event, but remembers a metallic taste in the mouth prior to the event. The patient had no bowel or bladder incontinence and has never experienced this type of episode before. He/she has no history of metabolic or electrolyte abnormalities, drug or alcohol use, or systemic illness.

CC: Unresponsive episode, with whole-body shaking for 3 min.

PMH: Hypercholesterolemia.

Meds: Simvastatin.

Allergies: None.

Family Hx: Cousin with a seizure disorder.

Social Hx: No smoking, 2–3 alcoholic drinks per week, no illicit drugs, patient works as a bus driver.

Initial scenario conditions

Patient sitting comfortably on hospital stretcher.

VS: Temp. 36.9 °C (98.4 °F), P 80, RR 16, BP 130/82, O₂ sat 99% RA.

Eyes: Pupils are equal, round, reactive to light, and accommodation.

Mouth: The edges of the patient's tongue show mild bruising consistent with recent biting.

Heart: Regular rate and rhythm, no murmurs.

Lungs: Clear to auscultation bilaterally.

Neurologic: Normal.

See the flow diagram in Figure 12.1 for further scenario details described below.

Case narrative, continued

The learner will have to interact with the patient and spouse regarding the findings on the head CT scan and about making plans for discharge.

The patient and spouse are unhappy about the patient not being admitted for an EEG. They demand medication to prevent future seizures. The patient also asks, "Doc, are you going to do anything about this cut on my tongue? It really hurts!"

If the learner does not address the patient's concerns or is rude in addressing them, the patient and spouse become more agitated and demanding.

If the learner politely addresses their concerns, but is not clear regarding follow-up or has no follow-up plan, the patient and spouse become increasingly concerned about getting appropriate follow-up care.

Once the learner is able to negotiate with and educate the patient and spouse appropriately, they become much more agreeable to discharge. If the learner does not address risk modification pertinent to seizures, then the spouse or patient can ask about when he/she can return to work as a bus driver, e.g. "Those kids are depending on me, I've got to get back to work Doc, when can I go?"

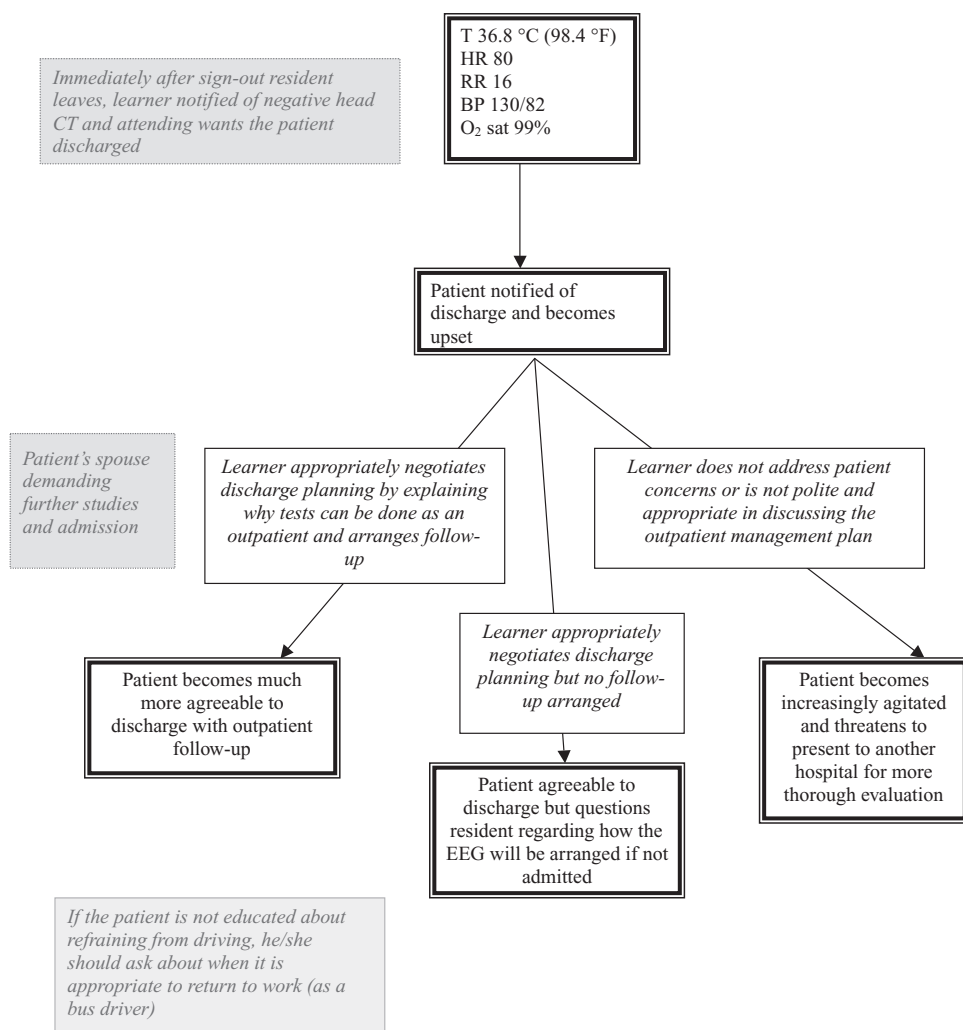


Figure 12.1 Scenario flow diagram: doctor–patient communication.

Instructor notes

First-time seizure

Diagnosis

- Based primarily on history from the patient or witness.
- Key history:³
 - History of alcohol or drug use.
 - Recent fall or trauma.
 - History of travel outside the United States.
 - History of ingestion.
 - Pregnancy.
 - Intracranial pathology.

Management

- Laboratory tests:
 - Usually not helpful in a patient who has returned to baseline; however, there is some evidence for the following:
 - Glucose.
 - Sodium.
 - Pregnancy test in women of childbearing age.
 - Serum calcium in those with a history of malignancy.
 - Lumbar puncture in patients who are immunocompromised.
- Imaging:
 - CT head without contrast.
- Medications used for recurrent seizures in the ED:
 - First-line:
 - Benzodiazepines:
 - Midazolam: 2 mg IV every 2 min if seizing \times 5 doses.
 - Lorazepam: as above.
 - Diazepam may be give IV or PR if no IV access can be obtained. IV lorazepam is superior to IV diazepam.
 - Second-line:
 - Phenytoin/phosphenytoin: 20–30 mg/kg IV.
 - Third-line:
 - Phenobarbital: 20–30 mg/kg IV. Very sedating and may cause hypotension and respiratory depression.
 - Levetiracetam: 1.5–2 g IV.
 - Valproic acid: 20 mg/kg up to 45–mg/kg. Contraindicated with hepatic disease.
- Electroencephalogram (EEG) should be done in the ED in patients who:
 - Are suspected of being in non-convulsive status epilepticus or in subtle convulsive status epilepticus.
 - Have received a long-acting paralytic.
 - Are in a drug-induced coma.

- Disposition:
 - Patients who return to baseline and have normal screening tests as listed above may be discharged with outpatient follow-up with neurology.

Doctor–patient communication

- When sending a patient home, it is important to educate him/her about when to return to the ED. For example, in this scenario, it is important to tell the spouse to bring the patient back to the ED if symptoms reoccur (i.e. if another event occurs or if the patient has altered mental status). It is also important to instruct them appropriately on risk modification (i.e. the patient should not be allowed to drive or be alone in or near any bodies of water).
- Negotiating with patients and their family members is an art. The process is aided by identifying common goals (“We all want to know what caused this event. We might not discover the reason today, but we will exclude the life-threatening possibilities.”).
- When a patient or family member seems unreasonably angry or upset, it is important to ask why he/she is unhappy with his/her care (“You seem upset. Have we addressed all your concerns during your Emergency Department visit today?”). The patient may have preconceived ideas about the illness that need to be explored further.
- If follow-up care is necessary, appropriate consultation should be initiated and the patient should receive necessary information for arranging a follow-up appointment.

Debriefing plan

Allow ~15 min for discussion.

Potential questions for discussion

- Were you satisfied with your interaction with the patient and the spouse? Are there things you would do differently?
- What are some ways to influence patients and their family members about a medical decision? How important is it to reach some point of agreement?
- Who bears the responsibility for arranging follow-up care?
- What are the indications for a stat EEG?
- When would you start anticonvulsant therapy in the ED?

Selected reading

1. Simpson M, Buckman R, Stewart M, *et al.* Doctor–patient communication: the Toronto consensus statement. *BMJ* 1991;393:1385–1387.
2. Maguire P, Pitceathly C. Key communication skills and how to acquire them. *BMJ* 2002;325:697–700.
3. Pillow MT, Malani N. *Focus On: Best Practices for Seizure Management in the Emergency Department*. Dallas, TX: American College of Emergency Physicians, January 2011. Available at www.acep.org/Content.aspx?id=72861 (last accessed May 18, 2012).
4. American College of Emergency Physicians. ACEP clinical policy: critical issues in the evaluation and management of adult patients presenting to the emergency department with seizures. *Ann Emerg Med* 2004;43:605–625.

Professionalism and communication between specialties

Educational goals

Learning objectives

1. Identify and appropriately respond to a colleague's unprofessional behavior [*Interpersonal and Communication Skills, Professionalism*].
2. Demonstrate knowledge in accessing the chain of administrative command [*Interpersonal and Communication Skills, Professionalism, Systems-based Practice*].

Critical actions checklist

- ☐ Recognize the presentation of appendicitis [*Medical Knowledge*]
- ☐ Identify unprofessional behavior and address it in a professional manner [*Interpersonal and Communication Skills, Professionalism*]
- ☐ Demonstrate knowledge of the appropriate chain of administrative command [*Systems-based Practice*]

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Adult mannequin in a hospital gown on a stretcher or hospital bed. Mannequin is male. Peripheral IV line is in place and simulator is connected to a cardiac monitor.

This scenario can be run effectively using either a standardized patient (SP) or a mannequin.

Props: (Optional) To be displayed on a plasma screen/computer screen or printed on handouts that are distributed when the participants ask for laboratory results:

- Images (see the online component for Professionalism and Communication Between Specialties, *Scenario 12.2.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - Radiology reading of abdominal ultrasound stating appendix is not visualized.
 - Radiology reading of CT of abdomen/pelvis stating appendix is not visualized.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Urinalysis.

Available in the treatment room:

- Bag mask and intubation equipment.
- Basic airway and code cart.
- Suction setup.

Distractor: None.

Actors:

- Patient is in considerable pain and annoyed at the delay in diagnosis. He has lines such as, “Why can’t you doctors figure out what is wrong?,” “Who is going to pay for all of these expensive tests?,” and “I’m going to leave and go to the hospital across town. The doctors there will know what’s wrong with me!”
- The surgical chief resident is verbally abusive and unwilling to consult on the patient.
- Sign-out resident hands off the patient to the learner. He/she provides the scenario background and a synopsis of the labs and imaging. The resident has already consulted with the surgical resident who is supposed to be discussing the case with his chief resident.
- The ED nurse repeatedly asks when the surgeon will arrive. The nurse may also react to the learner if they act inappropriately, calling the ED director to report poor patient care. She/he can also prompt calling the administrator on call if the learner seems unsure of how to proceed when they are not successfully communicating with the surgical chief.
- Hospital administrator or ED medical director.

Case narrative

Scenario background

Sign-out given by ED resident. The patient is a 35-year-old mildly obese man with progressively worsening lower abdominal pain for 1 day. An abdominal ultrasound examination and CT scan have been done and show equivocal results for appendicitis. A fluid bolus, IV fentanyl, and ondansetron have already been administered. The surgical resident has already been consulted, and has presented this patient to the surgical chief over the telephone.

CC: Pain in the right lower quadrant.

PMH: None.

Meds: None.

Allergies: None.

Family Hx: Unremarkable.

Social Hx: No smoking, alcohol, or illicit drugs, works as an auto mechanic.

Initial scenario conditions

Patient is complaining of considerable pain.

VS: Temp. 37.7 °C (99.9 °F), HR 112, RR 17, BP 166/96, O₂ sat 99% RA.

Eyes: Pupils are equally round and reactive to light.

Heart: Tachycardia, no murmurs.

Lungs: Equal bilaterally, clear to auscultation.

Abdomen: Point tenderness in the right lower quadrant with guarding and rebound.

See the flow diagram in Figure 12.2 for further scenario changes described below.

Case narrative, continued

The case begins when the learner receives sign-out from the outgoing resident, who is waiting for the surgical chief to evaluate the patient. Immediately following sign-out, the nurse asks the learner for more pain medication for the patient. The learner should subsequently introduce him/herself to the patient and possibly confirm the history of present illness and physical examination findings (pain in the RLQ).

The surgery chief resident calls into the simulated clinical space, stating that he/she has been paged for a consult. The tone is abrupt and discourteous. The surgical resident can make statements such as these: "Call me back when you have a *real* surgical case." "You ER docs *always* look for us to bail you out of your diagnostic dilemmas." "You know, I moonlight at an urgent care in 'X' town, I would *never* bother a surgeon for something as weak as this."

The surgical attending, if called, is not answering his pager/cell phone. The ED nurse may need to recommend contacting the medical director or the administrator on call to facilitate the flow of the scenario.

The goal of the simulation is to encourage the learner to contact the appropriate administrator. The surgical chief resident must be completely unreasonable and unwilling to participate in dialogue.

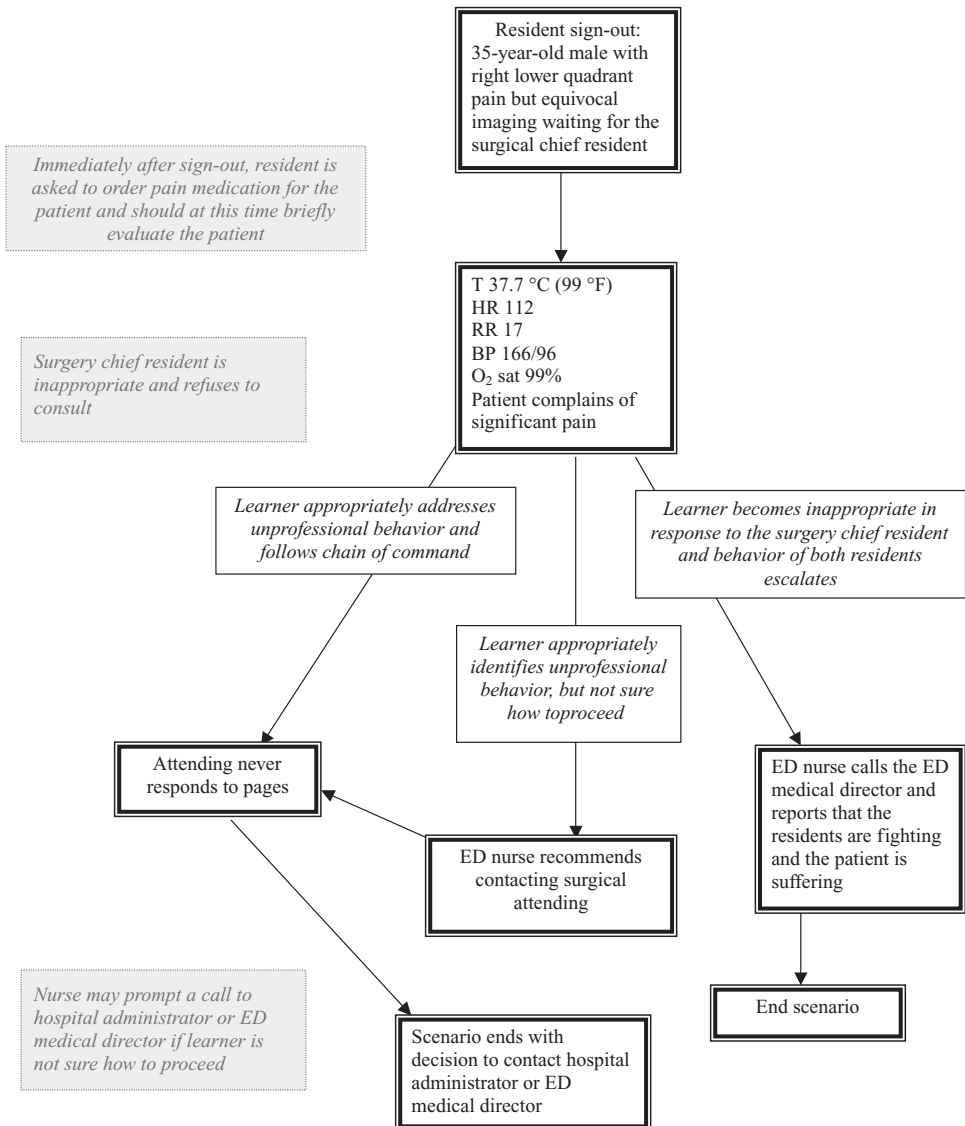


Figure 12.2 Scenario flow diagram: professionalism and communication between specialties.

Instructor notes**Teaching points**

- Courtesy among professionals is a necessity.
- There are policies in place at many institutions that address emergency department patient consultations. These policies may include a time period in which the consultant must respond.
- Every attempt should be made to mitigate any delay in patient care.
- It is important to recognize the appropriate level of administrator to activate related to the potential effect of a scenario on patient safety.

Debriefing plan

Allow ~15 min for discussion.

Potential questions for discussion

- What was this simulation scenario about?
- What are some techniques for diffusing high emotions such as those exhibited by the consultant?
- What are our institutional requirements and regulations regarding consultants? What state and federal statutes are applicable?
- How does professionalism directly affect patient care?

Selected reading

1. Baldwin DC, Daugherty SR, Rowley BD. Unethical and unprofessional conduct observed by residents during their first year training. *Acad Med* 1998;**73**:1195–1200.
2. Hickson GB, Pichert JW, Webb LE, *et al.* A complementary approach to promoting professionalism: identifying, measuring, and addressing unprofessional behaviors. *Acad Med* 2007;**82**:1040–1048.

Opiate-induced respiratory depression: managing medical mistakes

Educational goals

Learning objectives

Primary:

1. Demonstrate appropriate treatment of respiratory depression [*Medical Knowledge*].
2. Demonstrate appropriate use of narcotic reversal agents [*Medical Knowledge*].
3. Address a medical error with the affected patient and health care provider [*Professionalism, Interpersonal and Communication Skills*].

Secondary:

1. Demonstrate professionalism and communication skills in working with ED nurses [*Interpersonal and Communication Skills, Professionalism*].

Critical actions checklist

- ☐ Demonstrate correct bag-valve mask ventilation [*Medical Knowledge, Patient Care*]
- ☐ Administer naloxone [*Medical Knowledge*]
- ☐ Perform thorough and honest disclosure of mistake to patient and mother [*Interpersonal and Communication Skills, Professionalism*]
- ☐ Demonstrate constructive discussion with nurse regarding error [*Interpersonal and Communication skills, Professionalism*]

Simulation set-up

Environment: Emergency Department treatment area.

Mannequin: Simulator mannequin, the size of a 4-year-old boy, on a stretcher or hospital bed. The simulator is connected to a monitor and an IV line is in place. There should be a physical barrier between the area where the resident receives sign-out and the simulator's location. This separation may be accomplished by giving the report in the hallway outside the room or by using a barrier or screen to separate the room into two areas.

Props:

- None available during the case. The images and labs are all pending.

Available in the treatment room:

- Pediatric bag valve mask.
- Basic pediatric airway and code cart.
- Suction set-up.
- Broselow tape.
- Medications (labeled bags/syringes may be used in place of actual medicine syringes or bags):
 - Naloxone.
 - Epinephrine.
 - Atropine.
 - Rapid sequence intubation medications (sedative and paralytic typical for your institution).
 - 500 mL bags of IV fluids [0.9% normal saline (NS) or lactated Ringer's (LR)].

Actors:

- The patient will need vocalization only after successful resuscitation; his voice is tearful.
- The patient's mother is frantic at the bedside: "He was fine just a minute ago!" After the patient has received naloxone, she demands to know, "What did you do to my boy?"
- An ED nurse is needed to initially summon the learner to the scenario, administer medications, and participate in the resuscitation. The nurse has administered an incorrect dose of pain medication just prior to the learner's arrival at the bedside. Depending on the actions of the learner, the nurse may be apologetic at realizing the administration/dosing error or may be blaming and antagonistic to the learner after the error is discovered.
- A risk management representative should be available via "phone consultation" and may advise the learner to disclose the error.

Case narrative

Scenario background

The learner receives background information from the simulation facilitator, who states, “It is the beginning of your shift and you are given the following sign-out:”

The patient is a 4-year-old boy who began having vague abdominal pain 2 days ago. He had some decrease in his level of activity and appetite yesterday, which worsened today. He stayed home from preschool and curled up on the couch, clutching his abdomen. According to his mother, he had a tactile fever, some nausea, no vomiting, no diarrhea, no trauma, no sick contacts, and no testicular pain. Complete blood count, chemistries, fingerstick glucose, urinalysis, and abdominal ultrasound have been ordered and are all pending. A normal saline bolus, fentanyl, and ondansetron have been administered.

CC: Pain in the right lower quadrant.

PMH: Mild asthma.

Meds: Albuterol inhaler as needed.

Allergies: None.

Family Hx: Unremarkable.

Social Hx: No smoking, alcohol, or illicit drugs; he is in preschool.

As the scenario is being described to the resident, the nurse confederate interrupts, exclaiming, “We need a doctor in the room!”

Initial scenario conditions

The patient is apneic.

VS: Temp. 37.7 °C (99.9 °F), HR 40, RR 0, BP 68/37, O₂ sat 68% RA.

Fingerstick glucose test: 76 (optional if learner requests it).

Weight: 15 kg (if asked).

Eyes: Pupils pinpoint.

Heart: Bradycardia, no murmurs.

Lungs: Apneic, but clear breath sounds when/if given positive pressure ventilation.

Abdomen: Not distended.

See the flow diagram in Figure 12.3 for further scenario changes described below.

Case narrative, continued

The mother is frantic at the bedside, yelling, “Someone please help my baby, he was fine just a minute ago!”

Resuscitation efforts should include bag-mask ventilation, which will improve the patient’s oxygenation, blood pressure, and heart rate. If a reversal agent is not administered after an appropriate amount of time (instructor’s discretion), the nurse may tentatively ask if administering naloxone might be appropriate.

Following opiate reversal, the patient awakens and breathes spontaneously (if not previously paralyzed and intubated). If asked, the nurse will confirm that she gave the patient 100 µg of fentanyl (6.7 µg/kg). The ordered dose was 30 µg (2 µg/kg). If the learner does not ask about the dose, the nurse may pull the learner aside and admit to a dosing error.

The resident ultimately needs to tell the mother about the medication error, with or without the nurse present. This may be done in consultation with risk management. If the learner does not offer disclosure, the mother insists on knowing what went wrong. The scenario is complete once the disclosure has been made.

For a variation, to assess further aspects of professionalism and communication, the nurse might disclose the error and blame the physician (e.g. “If the handwriting on the chart had been legible I would not have made the error.”).

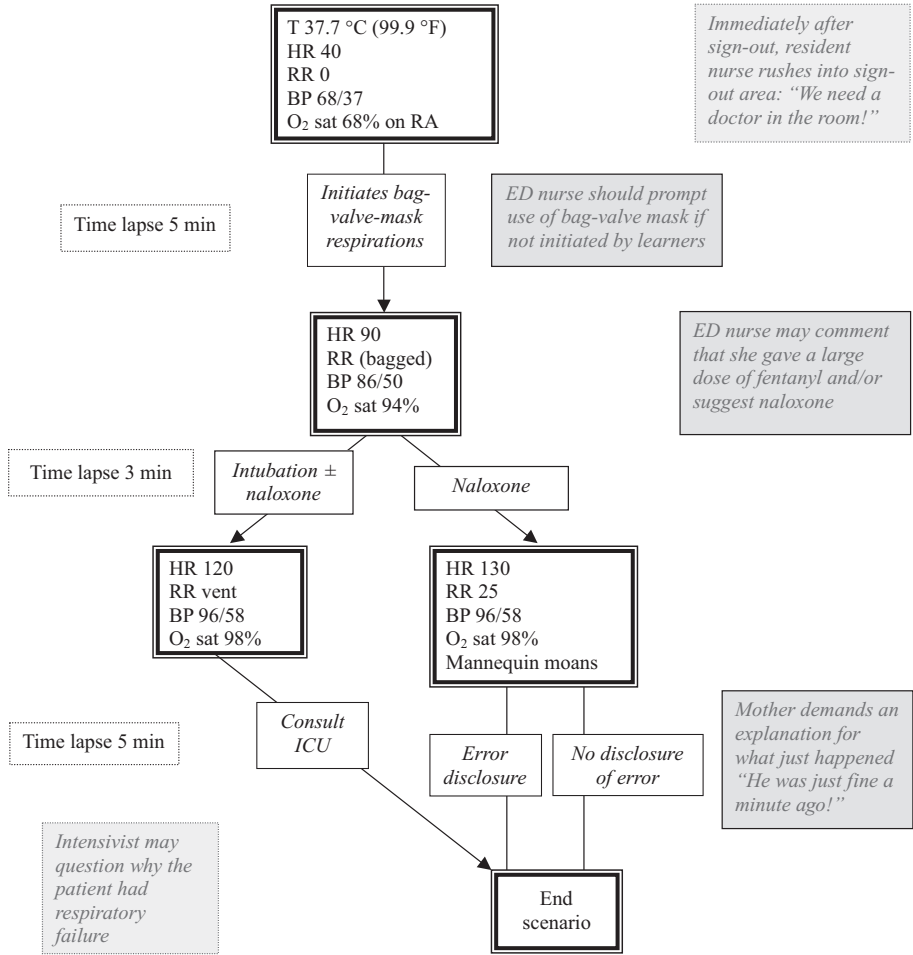


Figure 12.3 Scenario flow diagram: opiate-induced respiratory depression.

Instructor notes

Treatment of opiate overdose

- Naloxone is a high-affinity mu-opioid receptor competitive antagonist in the central nervous system, thus reversing opioid effects:
 - The recommended dose for naloxone is 0.01–0.1 mg/kg IV every 2 min until the desired effect is achieved.
 - A maintenance dose can be repeated as necessary to maintain narcotic reversal.

Medical error disclosure

- Quick disclosure of clinical errors and the offer of compensation, when appropriate, can decrease the incidence of lawsuits and resolve legal issues faster.¹
- Current thinking suggests that physicians have an ethical duty to disclose errors fully when disclosure furthers the patient's health, respects patient autonomy, or enables the patient to be compensated for harm.
- Data suggest that most patients want to know about errors committed during the course of their care, whether or not these errors make a difference in outcome.²
- Notifying the correct authorities, including the risk management department and the hospital safety supervisor, can help prevent future mistakes.

Debriefing plan

Allow ~15–30 min for discussion.

Potential questions for discussion

- What was this simulation about?
- How does naloxone work?
- What are the possible side effects of naloxone?
- What kinds of mistakes have you witnessed in clinical settings?
- Should mistakes be disclosed to patients even if there is no resultant morbidity? Why?
- Who should be notified when a medical error occurs?
- Should the individual who administered the medication be present in the room if the family is informed?

Selected reading

1. Kachalia A, Kaufman SR, Boothman R, *et al.* Liability claims and costs before and after implementation of a medical error disclosure program. *Ann Intern Med* 2010;**153**:213–221.
2. Hobgood C, Peck CR, Gilbert B, *et al.* Medical errors – what and when: what do patients want to know? *Acad Emerg Med* 2002;**9**:1156–1161.

Notifying family of patient death

Educational goals

Learning objectives

Primary:

1. Demonstrate appropriate death notification skill when informing family members of a patient's death [*Interpersonal and Communication Skills, Professionalism*].

Secondary:

1. Demonstrate compassion, professionalism, and communication skills when talking to family members [*Interpersonal and Communication Skills, Professionalism*].
2. Use available resources to facilitate family notification of a patient's death [*Systems-based Practice*].

Critical actions checklist

- ☐ Enlist support of chaplain or nursing staff after patient has died [*Professionalism, Systems-based Practice*]
- ☐ Make proper introduction to family, invite the family to sit, and give a synopsis of events [*Interpersonal and Communication Skills, Professionalism*]
- ☐ Address patient by name and state that he/she has died [*Interpersonal and Communication Skills, Professionalism*]
- ☐ Tell the family that a coroner will be contacted, that they will have a chance to view the body, and that you will return to answer further questions [*Systems-based Practice, Interpersonal and Communication Skills, Professionalism*]

Simulation set-up

Environment: Emergency Department treatment area and a nearby secluded room or area with chairs for the family.

Mannequin: Male simulator mannequin, intubated, on a stretcher, with nurse performing chest compressions. A cardiac monitor is connected to the simulator, displaying asystole. The mannequin is moulded with a gray wig to appear elderly.

Props: There are no imaging or labs available for this case.

Available in the treatment room:

- Code cart with defibrillator.
- Bag-valve mask.
- Medications (labeled bags/syringes may be used in place of actual medicine syringes or bags):
 - IVF [0.9% normal saline (NS) and lactated Ringer's (LR)].
 - Epinephrine.
 - Atropine.
 - 50% dextrose solution (D50).

Actors:

- Patient's wife appears to be stunned and in shock. She makes comments such as, "He was just talking about buying a new golf club," and "He has been so careful about his diet and exercise. How could this happen?"
- At least one adult child of the patient. He/she exhibits a range of emotions, from tearful to angry that the resuscitation has been unsuccessful.
- Two nurses: one to administer medications and one to document the care provided and assist the family.
- Respiratory therapist may ventilate the patient.
- Paramedics are able to provide history and assist with compressions.

If the case is being run with multiple learners at the same time, some of the learners can perform the ventilations, do compressions, or assist the family, eliminating the need for some of the actors.

Case narrative

Scenario background

Joseph Webb, a 78-year-old man, collapsed while at the shopping mall with his wife and two adult children. Paramedics were delayed in their arrival at the scene. When they arrived, they found the man lying on the floor, unconscious. According to his wife, before collapsing he had become very weak and complained of crushing chest pain and difficulty breathing. He did not receive bystander CPR. EMS personnel initiated CPR and intubated the patient at the scene, which gave a positive color change in the end-tidal carbon dioxide detector. The patient's initial rhythm was PEA. CPR continued en route for 10 min, during which time the patient developed asystole. The patient has received three rounds of epinephrine.

EMS personnel should present the background information.

CC: Cardiac arrest.

PMH: Coronary artery disease, hypertension, hypercholesterolemia, myocardial infarction at age 72 years.

Meds: Aspirin, lisinopril, carvedilol, simvastatin, nitroglycerin.

Allergies: None.

Family Hx: Father had heart disease; mother had breast cancer.

Social Hx: Quit smoking 20 years ago, occasional alcohol, no illicit drugs; married with two adult children.

Initial scenario conditions

The patient is an elderly man who is intubated, asystolic, and receiving adequate chest compressions and ventilations with a bag-valve mask.

VS: Temp. 36.6°C (97.9°F), HR asystole on monitor, RR ventilated rate, BP and O₂ sat not registering.

Fingerstick glucose test: 120 (optional if learner requests it).

Eyes: Pupils are equal and non-reactive.

Heart: No heart sounds.

Lungs: Air movement is heard bilaterally with ventilation.

Case narrative, continued

Soon after the learner assumes care of the patient, the family rushes up to the bed and hysterically asks what is going on. The nurse asks if they want to stay in the treatment room or wait nearby, and the family elects to go to a waiting room. Despite efforts by the learner, the patient does not respond to resuscitative efforts and remains in asystole. If the learner does not declare the patient dead after reasonable effort, he/she should be prompted by the nurse to do so.

The learner then needs to notify the family of the patient's death. If the learner takes appropriate actions (i.e., sits down with the family in a non-public area; calls the patient by name; clearly states, in a sympathetic manner, that the patient has died; and offers the family the opportunity to view the body), the family responds with appropriate grief. However, if the learner seems rushed, does not use the patient's name, or does not clearly state that the patient is "dead," then the family acts confused and angry. The scenario will end after the family's response regardless of the learner's approach.

See the flow diagram in Figure 12.4 for further scenario changes described below.

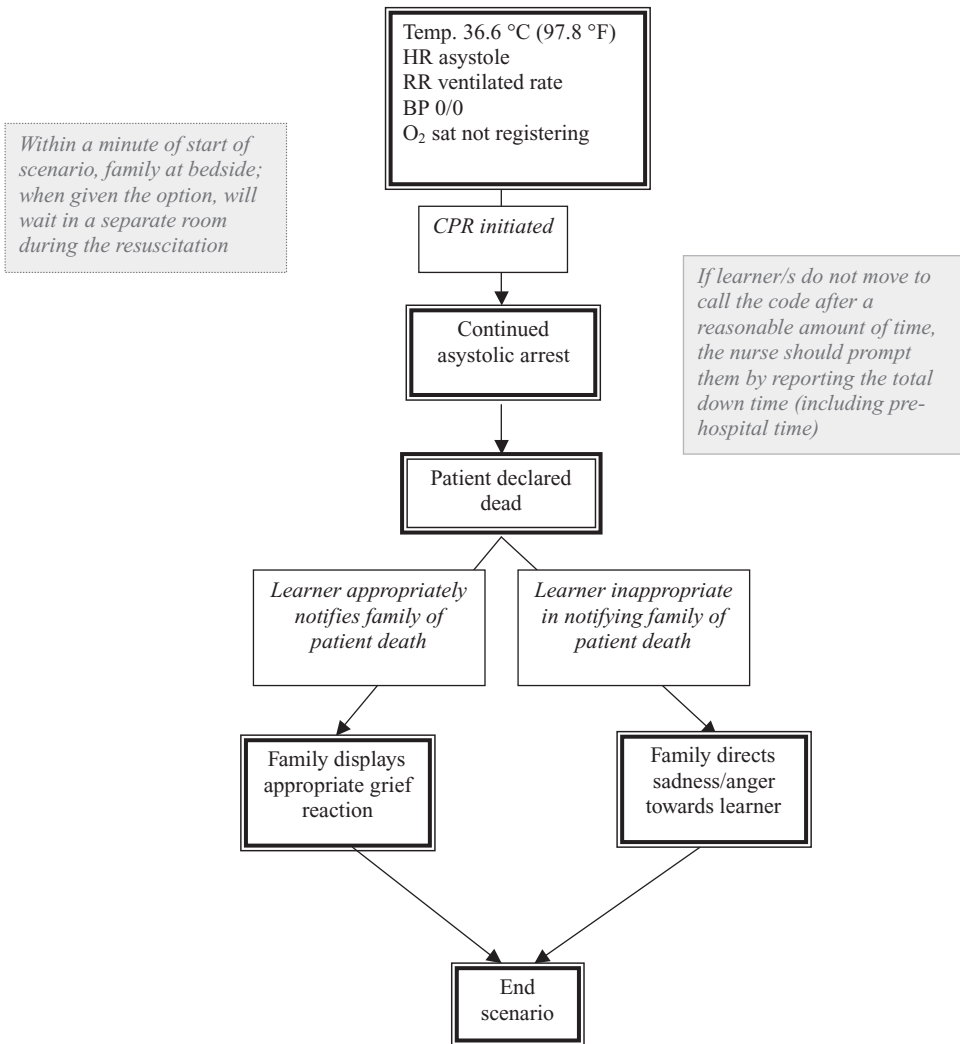


Figure 12.4 Scenario flow diagram: notifying family of patient death.

Instructor notes

You may decide to do a formal review of how to do death notification instead of a loosely structured debriefing. An excellent guide to doing this is available.²

Death notification

- Logistics:
 - During resuscitation, the family should be given the option to stay and watch or wait nearby (depending on your department's policies).
 - Choose a quiet and relatively empty room with plenty of seating as a place to inform the family of the patient's death.
 - Always have an unobstructed path to the door.
 - After a death, it is important to collect your thoughts and mentally prepare before meeting the family. Find out which family members are present and what they know about the patient's condition.
 - Find out the *name* of the patient.
- Resources:
 - Bring a chaplain, social worker, nurse, or other doctor with you. Do not speak with the family alone or leave them without a staff member to whom they may put questions after you have finished speaking.
- Delivery:
 - Introduce yourself and the rest of the team. Sit down and invite the family to sit down. This shows that you are not in a hurry and minimizes the chance that a family member will faint and fall.
 - Ask the family member who seems most stable or calm a question about the patient or situation to gauge his/her perception of the event. "What was the first thing that seemed to be abnormal?"
 - Briefly, in a few phrases and in plain language, sequentially summarize what happened. Do not draw out the account with unnecessary details.
 - With sympathy, say that the patient (using their name) has died. Do not use terms such as "passed on" or "is no longer with us."
 - Allow time for a grief response. It is okay to give physical comfort.
 - Phrases such as "Everything was done" and "The patient did not suffer" are appropriate when they are true.
 - Expressions such as "You have my sympathy" or "I know this is very hard for you," are better than "I'm sorry," which can be interpreted as admission of guilt.
 - Explain that a coroner will be contacted and that the family will have the opportunity to view the body if they choose to do so. After this, inquiries can be made concerning autopsy and organ donation.

Debriefing plan

Allow at least 15 min for discussion: a death notification scenario debriefing tends to be more involved than debriefings after other scenarios.

Potential questions for discussion

- How did you feel about your interaction with the patient's family?
- What do you wish you had done differently?
- What are some important things to do or know after a patient has died and before entering the room where the family are?
- What are some practical ways to show empathy?
- What are some cliché phrases to avoid?
- What are the stages of grief?
- What are good ways to deal with a family member's denial, anger, or guilt?

Selected reading

1. Hobgood C, Harward D, Newton K, Davis W. The educational intervention "GRIEV'ING" improves the death notification skills of residents. *Acad Emerg Med* 2005;**12**:296–301.
2. Baile WF, Buckman R, Lenzi R, *et al*. SPIKES – a six-step protocol for delivering bad news: application to the patient with cancer. *Oncologist* 2000;**4**:302–311.
3. Nardi TJ, Keefe-Cooperman K. Communicating bad news: a model for emergency mental health helpers. *Int J Emerg Ment Health* 2006;**8**:203–207.

CHAPTER 13 Trauma emergencies

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Major burn

Educational goals

Learning objectives

Primary:

1. Demonstrate proper performance of a trauma assessment [*Medical Knowledge, Patient Care, Interpersonal and Communication Skills*].
2. Identify and properly manage airway compromise in a burn patient [*Medical Knowledge, Patient Care*].
3. Demonstrate proper fluid resuscitation in a major burn patient [*Medical Knowledge, Patient Care*].
4. Recognize and properly manage full thickness burns of the chest [*Medical Knowledge, Patient Care*].

Secondary:

1. Know the indications for transfer to a specialized burn center [*Systems-based Practice*].
2. Identify carbon monoxide (CO) and cyanide (CN) exposure as potential diagnoses in the evaluation of a major burn patient with altered mental status [*Medical Knowledge*].

Critical actions checklist

- ☐ Obtain appropriate IV access (two large-bore IVs) [*Patient Care*]
- ☐ Perform endotracheal (ET) intubation for airway compromise [*Medical Knowledge, Patient Care*]
- ☐ Order CO level [*Medical Knowledge*]
- ☐ Perform escharotomy for compromised ventilation secondary to chest burns [*Medical Knowledge, Patient Care*]
- ☐ Utilize established formula (i.e. Parkland) to calculate fluid resuscitation [*Medical Knowledge*]
- ☐ Consult burn center [*Interpersonal and Communication Skills, Professionalism, Systems-based Practice*]

Critical actions can be changed to address the educational needs of the learner. For example, a resident preparing for oral boards may have more specific critical actions oriented towards oral board review (e.g. tetanus administration).

Emergency Medicine Simulation Workbook: A Tool for Bringing the Curriculum to Life, First Edition. Edited by Traci L. Thoureen and Sara B. Scott.

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Simulation set-up

Environment: Trauma resuscitation bay/room.

Mannequin: Simulator mannequin, with chest/back/neck burn moulage, on a backboard with hard cervical spine collar. Burn can be moulaged with a layer of flesh-colored gelatin with charcoal covering the ridges and fake-blood in the crevices. Mannequin should be male with a non-rebreather (NRB) facemask in place. He has soot (moulaged with black mannequin make-up) around the nose and mouth. He is naked and covered by a sheet.

If you do not have a backboard or cervical collar available, you may improvise with cardboard supplies or Styrofoam cut to size.

Props: To be displayed on a plasma screen/computer screen or printed out on handouts in the scenario room when asked for/return from laboratory:

- Images (see online component for Major Burn, *Scenario 13.1.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - Chest X-ray which is normal.
 - Post-intubation chest X-ray showing good ET tube placement.
 - Radiology read of normal CT head.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Lactate.
 - Coagulation panel.
 - Liver function tests.
 - Type and screen.
 - Carboxyhemoglobin level.
 - Arterial blood gas.

Any imaging or laboratory work not provided (such as a cervical spine X-rays or CT cervical spine) can be verbally reported as normal if the learners order the study.

Available in the treatment room:

- Basic airway and code cart.
- Medications:
 - Liter bags of 0.9% normal saline (NS) and lactated Ringer's (LR).
 - Rapid sequence intubation (RSI) medications prelabeled in syringes (paralytic and induction medication of choice for your institution).
 - Sedative of choice for your institution in prelabeled IV bag or syringe.
 - Labeled syringes of analgesic medication (e.g. fentanyl, morphine).
 - Tetanus toxoid in prelabeled syringe.

- Procedure tray with betadine, chlorhexidine, scalpel, and gauze.
- (Optional) Fiber-optic scope, video-assisted laryngoscope, cricothyrotomy tray.

Distractor: None.

Actors:

- Paramedic(s) are able to provide information about the scene,
- Patient voice is male. Patient should sound confused and lethargic. He is not able to follow commands or answer questions appropriately.
- ED nurse can start IVs and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed.
- Burn center available via “phone consultation.”

Case narrative

Scenario background

A 26-year-old male found in an apartment fire. His charred clothing was removed at the scene. There were no other victims in the apartment complex as the fire started in the patient's living area and was contained within his apartment. The patient had an 18-gauge IV placed in the right antecubital fossa and 500 mL of LR was given during transport. EMS also placed the patient on an NRB facemask.

Background may be presented prior to case as an EMS medical consult or by EMS on arrival.

PMH: Unknown.

Meds: Unknown.

Allergies: Unknown.

Family Hx: Unknown.

Social Hx: Unknown.

Initial scenario conditions

Young male brought in on backboard with cervical spine collar. Patient is moaning in pain.

VS: Temp. 35.8 °C (96.5 °F), BP 100/60, HR 120, RR 26, O₂ sat 99% on 100% NRB.

Head: Head is atraumatic, soot in nares and mouth.

Eyes: Pupils 4 mm and reactive to light.

Neck: Cervical collar in place. Full thickness burns extend part way up the neck.

Heart: Tachycardic and regular, distal pulses diminished.

Lungs: Tachypneic, shallow respirations, coarse breath sounds with wheezing.

Chest: Full thickness burns over entire chest and on to back.

Abdomen: Full thickness burns extend to mid-abdomen. Diminished bowel sounds.

Extremities: No gross deformities.

Skin: Full thickness burns as noted above.

Neurologic: Withdraws and moans in response to pain. No eye opening.

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners. For example, If your mannequin does not have reactive pupils, you can verbally report the pupillary examination when it is requested.

See the flow diagram in Figure 13.1 for further scenario changes described below.

Case narrative, continued

Learners should initially perform a primary trauma survey, obtaining appropriate IV access, ordering imaging and laboratory work, and appropriately administering IV fluids and pain medication. Identification of respiratory compromise secondary to inhalational injury should be managed with intubation. Failure to manage the airway appropriately after 5 min will lead to further respiratory decompensation.

For advanced learners with a high-fidelity mannequin, the mannequin can be programmed to simulate a difficult airway necessitating a fiber-optic or video-assisted approach or even cricothyrotomy.

Following appropriate airway management, there is an initial period of stabilization. During this time, any ordered imaging/labs return. The case may end here with consultation/transfer to a burn center for junior learners and students.

For advanced learners, after ~3 min, the patient begins to deteriorate, becoming difficult to bag or triggering the high-pressure alarms on the ventilator.

Learners should identify decreased compliance of the chest wall secondary to full thickness burns as the cause of difficult ventilation and an escharotomy should be performed to stabilize the patient. If your mannequin set-up does not allow for an escharotomy actually to be performed, the learner can describe the steps of the procedure verbally. If escharotomy is not performed, the patient becomes increasingly difficult to ventilate and ultimately deteriorates to a PEA arrest.

The case ends when the patient is stabilized and transfer to a burn center has been arranged.

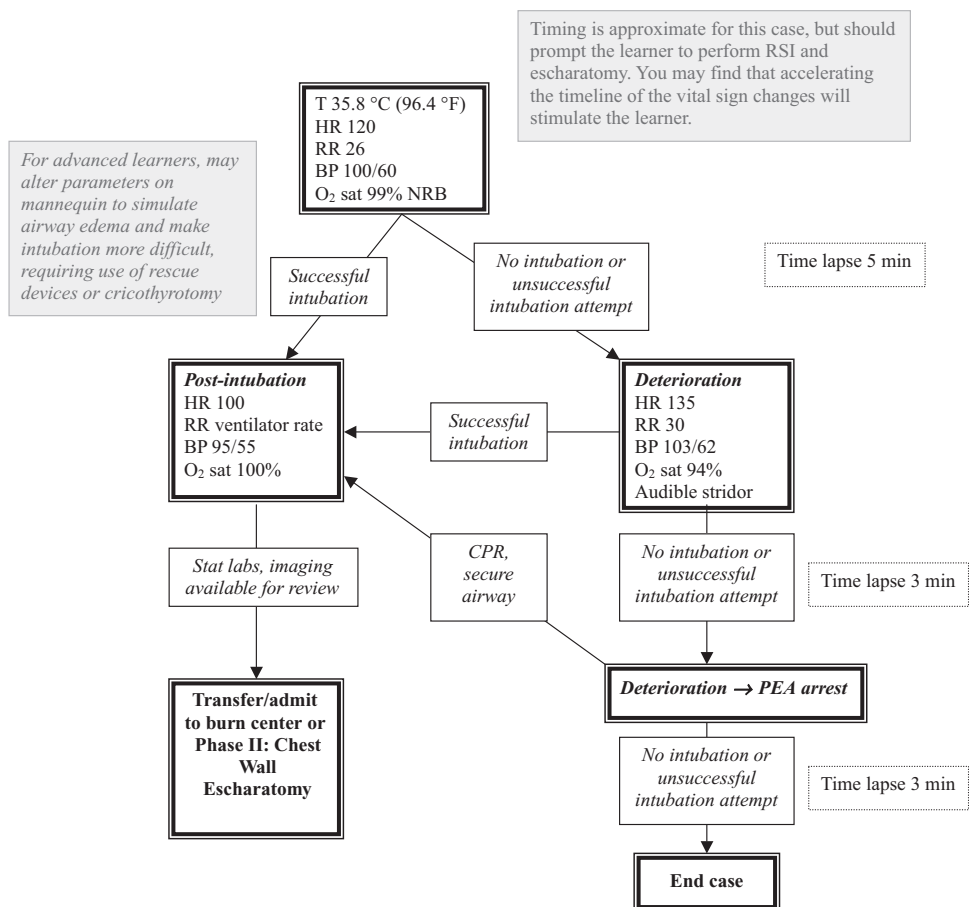


Figure 13.1 Scenario flow diagram: major burn.

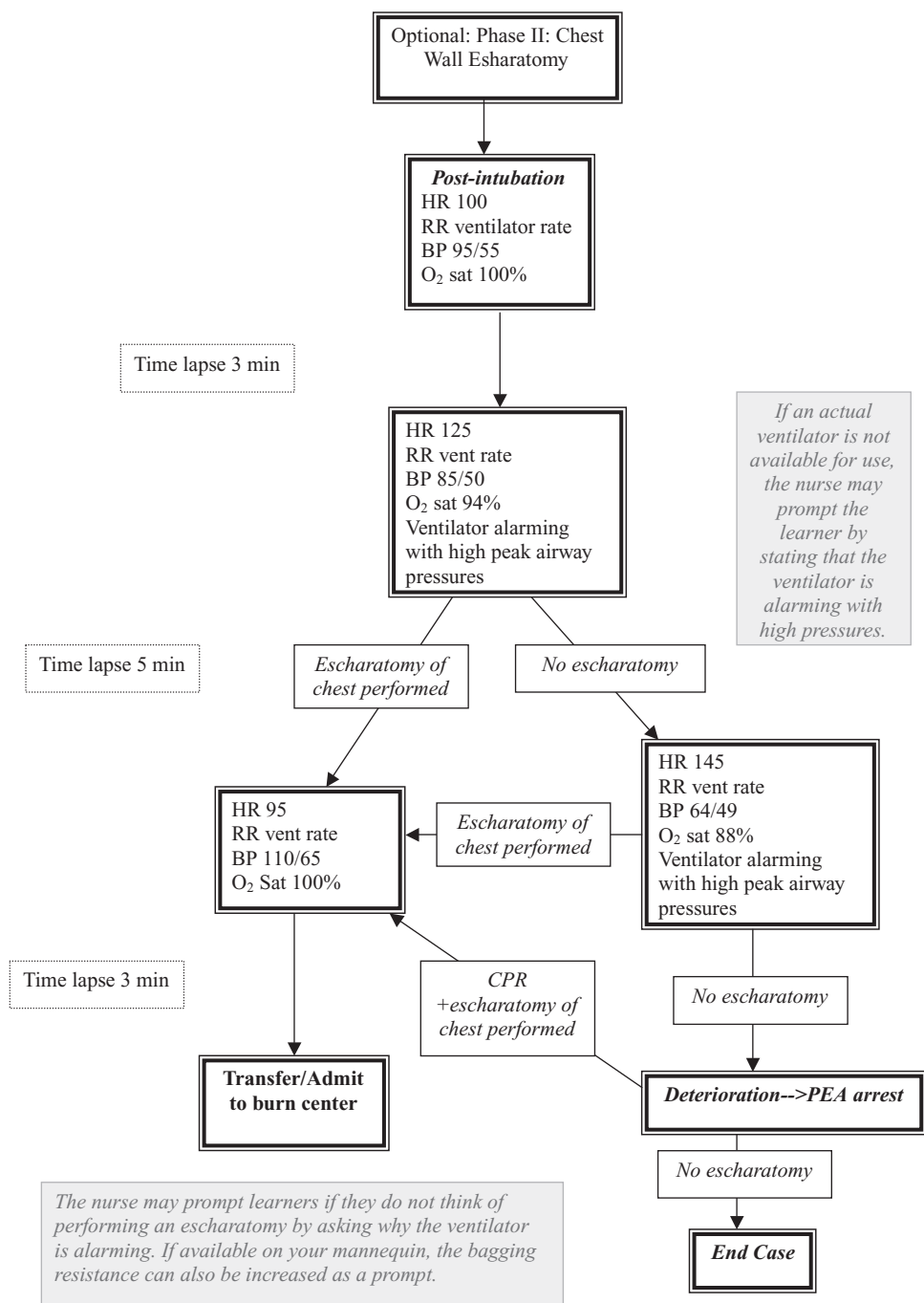


Figure 13.1 (Continued)

Instructor notes

Pathophysiology

- Burns can be caused by heat, electricity, radiation, chemicals, light, or friction.
- Categorized based on depth and extent of injury.

Clinical features

- Depth of injury is categorized as follows:
 - Superficial burn (first degree):
 - Involves epidermis and causes dry, red/pink, painful lesions.
 - Partial thickness burn (second degree)
 - Extends into the dermis and causes moist, pink, painful lesions with blistering.
 - Can be subdivided into superficial and deep partial thickness burns.
 - Full thickness burn (third degree)
 - Extends to subcutaneous tissue and causes dry, white/brown, leathery, insensate lesions.
 - Full thickness burn with extension into underlying muscle/bone (fourth degree):
 - Appears charred with eschar and is insensate.
- Extent of injury based on total body surface area (TBSA) with partial thickness or full thickness burns (superficial burns not counted):
 - Rule of nines (adult): 18% for anterior torso, 18% for back, 18% for each lower extremity, 9% for each upper extremity, 9% for the head and 1% for the perineal area.
 - Lund Browder Chart (children): accounts for changing size of head and legs in calculation of burn areas. Most accurate method in children.
 - May use online calculators such as at <http://www.sagediagram.com/>.

Diagnosis

- Primarily historical.

Management

- Airway/breathing:
 - 100% oxygen for suspected inhalation injury or carbon monoxide exposure.
 - All patients with suspected inhalation should have the carboxyhemoglobin level checked.
 - Airway edema from inhalation of superheated gases may cause rapid airway compromise. Endotracheal intubation should be performed for patients with suspected airway involvement.
- Fluid management:
 - IV fluids with crystalloid (LR preferred).
 - Established formulas (e.g. Parkland) should be used:
 - Parkland formula: $4 \text{ mL} \times \text{TBSA with partial/full thickness burns} \times \text{weight (kg)}$.
 - Half of calculated volume given in first 8 h, remainder given over next 16 h.

- Estimate the amount of fluid to provide during the first hour by (TBSA with partial/full thickness burns \times weight in kg)/4.
 - Patients with inhalation injuries or concomitant trauma may require more fluid resuscitation than calculated using established formulas.
- Medications:
 - Pain control with appropriate analgesics.
 - Tetanus booster (or immune globulin).
 - Avoid application of topical creams/ointments prior to transfer to burn center.
- Escharotomy indications:
 - Circumferential burns with compromised perfusion to an extremity.
 - Extensive burns to the chest and neck with compromised ventilation or circulation resulting from the eschar.
- Consult/transfer to burn center is indicated for the following:
 - Partial thickness burns $>20\%$ of TBSA in adults or $>10\%$ in children younger than 10 years and adults older than 50 years.
 - Full thickness burns $>5\%$ of TBSA at any age.
 - Burns involving the face, eyes, ears, hands, feet, or perineum that may result in functional or cosmetic impairment.
 - Burns caused by caustic chemicals or high-voltage electricity.
 - Burns associated with inhalation injury or major trauma.
 - Burns in patients with significant co-morbid diseases or in those at the extremes of age (infants/elderly).

Debriefing plan

Plan for ~30 min for discussion.

Potential questions for discussion

- What is the standard approach to a burn patient?
- How should IV access be established? What type of IV fluids should be administered and at what rate?
- What special considerations should be given to patients with suspected inhalation injury?
- What is the treatment for carbon monoxide exposure?
- What are the indications for escharotomy?
- How do you perform escharotomy?
- What are the criteria for consult/transfer to a burn center?

Selected reading

1. Gomez R, Cancio L. Management of burn wounds in the emergency department. *Emerg Med Clin North Am* 2007;**25**(1):135–146.
2. Cancio LC. Airway management and smoke inhalation injury in the burn patient. *Clin Plast Surg* 2009;**36**(4):555–567.
3. Bethel CA, Mazzeo AS. Burn care procedures. In: Roberts JR, Hedges JR, eds. *Clinical Procedures in Emergency Medicine*, 5th edn. Saunders: Philadelphia, 2010, pp. 692–714.
4. Foot C, Host D, Campher D, et al. Moulage in high-fidelity simulation – a chest wall burn escharotomy model for visual realism and as an education tool. *Simul Healthcare* 2008;**3**(3):183–185.

Polytrauma – pneumothorax and pelvic fracture

Educational goals

Learning objectives

Primary:

1. Demonstrate proper performance of a trauma assessment [*Medical Knowledge, Patient Care, Interpersonal and Communication Skills*].
2. Identify and properly manage a pneumothorax [*Medical Knowledge, Patient Care*].
3. Recognize and appropriately manage hypotension in a polytrauma patient [*Medical Knowledge, Patient Care*].
4. Demonstrate appropriate use of the Focused Assessment with Sonography in Trauma (FAST) examination [*Medical Knowledge, Patient Care*].
5. (Option for junior/senior learners) Identify and properly manage a pelvic fracture [*Medical Knowledge, Patient Care*].

Secondary:

1. Demonstrate appropriate interaction with patient's family members [*Interpersonal and Communication Skills*].
2. (Option for junior/senior learners) Recognize indications for interventional radiology (IR) consultation [*Systems-based Practice, Medical Knowledge*].

Critical actions checklist

- ☐ Obtain appropriate IV access (two large-bore IVs) [*Patient Care*]
- ☐ Administer appropriate fluid resuscitation with crystalloids and colloids [*Medical Knowledge, Patient Care*]
- ☐ Perform and interpret FAST examination [*Medical Knowledge*]
- ☐ Identify pneumothorax and appropriately manage with chest tube [*Medical Knowledge, Patient Care*]
- ☐ (Option: junior/senior learners) Stabilize pelvic fracture with pelvic binder or sheet [*Medical Knowledge, Patient Care*]

Critical actions can be changed to address the educational needs of the learner. For example, a resident preparing for oral boards may not actually have to place a chest tube but may be expected to perform critical actions more specifically oriented towards oral board review (e.g. pregnancy test ordered, IR consultation obtained).

Simulation set-up

Environment: Trauma resuscitation bay / room.

Mannequin: Female simulator mannequin, with bruising moulaged across chest from a seat belt and a left ankle in a pre-hospital splint. Blood is on the sheet under the mannequin and coming from the vagina, which can be moulaged with red food coloring mixed with water. Mannequin is on a backboard with cervical collar in place and non-rebreather (NRB) mask.

If you do not have a splint, backboard, or cervical collar available, you may improvise with cardboard supplies or Styrofoam cut to size.

Props: To be displayed on a plasma screen / computer screen or printed out on handouts in the scenario room when asked for / return from laboratory:

- Images (see online component for Polytrauma, *Scenario 13.2.ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - Chest X-ray with pneumothorax.
 - Pelvic X-ray with open-book pelvic fracture.
 - Left lower extremity X-ray with fibular fracture.
 - FAST images that show no free fluid.
 - CT head that shows no intracranial injury.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Lactate.
 - Coagulation panel.
 - Liver function tests.
 - Type and cross.
 - Serum pregnancy test.

Any imaging or laboratory work not provided (such as a cervical spine series or CT cervical spine) can be verbally reported as normal if ordered by the learners.

Available in the treatment room:

- Basic airway and code cart.
- Medications (actual containers filled with water replacing the medication, or labeled IV bags and syringes):
 - IVF: liter bags of normal saline (NS) and lactated Ringer's (LR).
 - IV analgesics (e.g. fentanyl, morphine).
- Blood products labeled as packed red blood cells, platelets, fresh frozen plasma.
- Procedure tray with instruments for chest tube thoracostomy.
- Pelvic binder or extra bed sheet.

Distractor: None.

Actors:

- Paramedic(s) are able to provide information about the scene.
- Patient voice is female. Patient is in pain but is able to follow commands and answer questions appropriately.
- ED nurse can start IVs and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed.
- General surgery, urology, orthopedic surgery, and IR available by “phone consultation.”

Case narrative

Scenario background

A 35-year-old female was a restrained driver in a head-on motor vehicle collision. She required extrication from the vehicle due to entrapment. Transient loss of consciousness was reported and air bags had deployed. She complains of severe chest pain and bilateral hip pain. The driver of the other vehicle was declared dead at the scene. The patient had an 18-gauge IV placed in the right antecubital fossa by EMS and 1 L of LR was given during transport. EMS placed the patient on an NRB mask because of the complaints of chest pain.

Background may be presented prior to case as a phone-in EMS medical consult or by EMS on arrival.

PMH: Appendectomy.

Meds: None.

Allergies: Sulfa.

Family Hx: Non-contributory.

Social Hx: Denies drugs, alcohol or tobacco. Married with one child.

Scenario conditions initially

A young female brought in on a backboard with cervical collar. The patient is moaning in pain and complaining that she cannot breathe.

VS: Temp. 36.4 °C (97.6 °F), BP 105/69, HR 136, RR 26, O₂ sat 100% on NRB.

Head: Atraumatic.

Eyes: Pupils 4 mm and reactive.

Mouth: Airway patent, no malocclusion.

Neck: Trachea deviated toward the right + jugular venous distension.

Heart: Tachycardic and regular, distal pulses present.

Lungs: Tachypneic, no breath sounds on the left.

Chest: Bruising from seat belt shoulder strap.

Abdomen: Soft, non-tender, non-distended. No bruising on abdomen.

Genitourinary/rectal: Vaginal bleeding noted. Normal rectal tone.

Extremities: Pelvis unstable, deformity and bruising left ankle.

Skin: Bruising on chest and left ankle.

Neurologic: Moaning in pain, eyes open at baseline. Responds to questions and follows commands appropriately. No numbness reported. Has difficulty moving lower extremities secondary to pain.

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners (e.g. when the learner attempts to examine for a stable pelvis or if they ask for the examination of the pelvis it should be verbally reported as unstable).

See the flow diagram in Figure 13.2 for further scenario changes described below.

Case narrative, continued

Learners should initially perform a primary trauma survey. Large-bore IVs, imaging, and laboratory work should be ordered, FAST performed, IV fluid resuscitation started, and pain medication given. The learner must identify respiratory and circulatory compromise secondary to tension pneumothorax. This should be managed with chest tube thoracostomy either with or without prior needle decompression. Failure to manage the pneumothorax appropriately after 5 min will lead to further respiratory and circulatory decompensation regardless of other interventions (e.g. intubation, IVFs).

If performance of the actual procedure is not one of your learning objectives then the learners can simply state that they would place a chest tube

Following appropriate chest tube placement, vital signs improve and a secondary survey can begin. For students and more junior learners, the patient's vital signs can normalize after chest tube placement and the case can end there.

For junior/senior learners, the patient will become more hypotensive and tachycardic during the secondary survey. The pelvic fracture should be identified as the cause and a pelvic stabilizer placed and blood transfusion begun. Results of ordered imaging and laboratory work can return at this time.

The case ends when the patient is stabilized, orthopedic surgery and IR have been consulted for embolization, and transfer to a trauma center has been arranged.

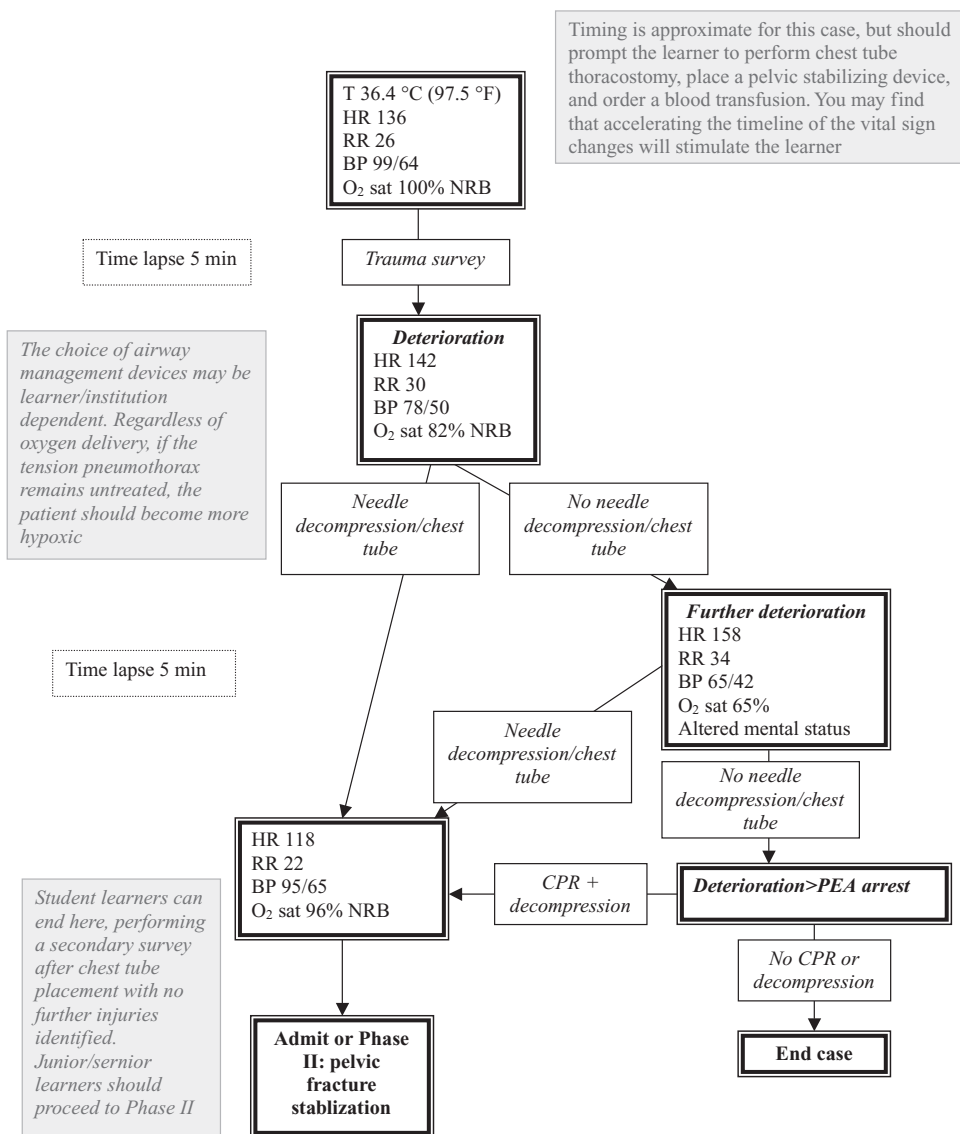


Figure 13.2 Scenario flow diagram: polytrauma.

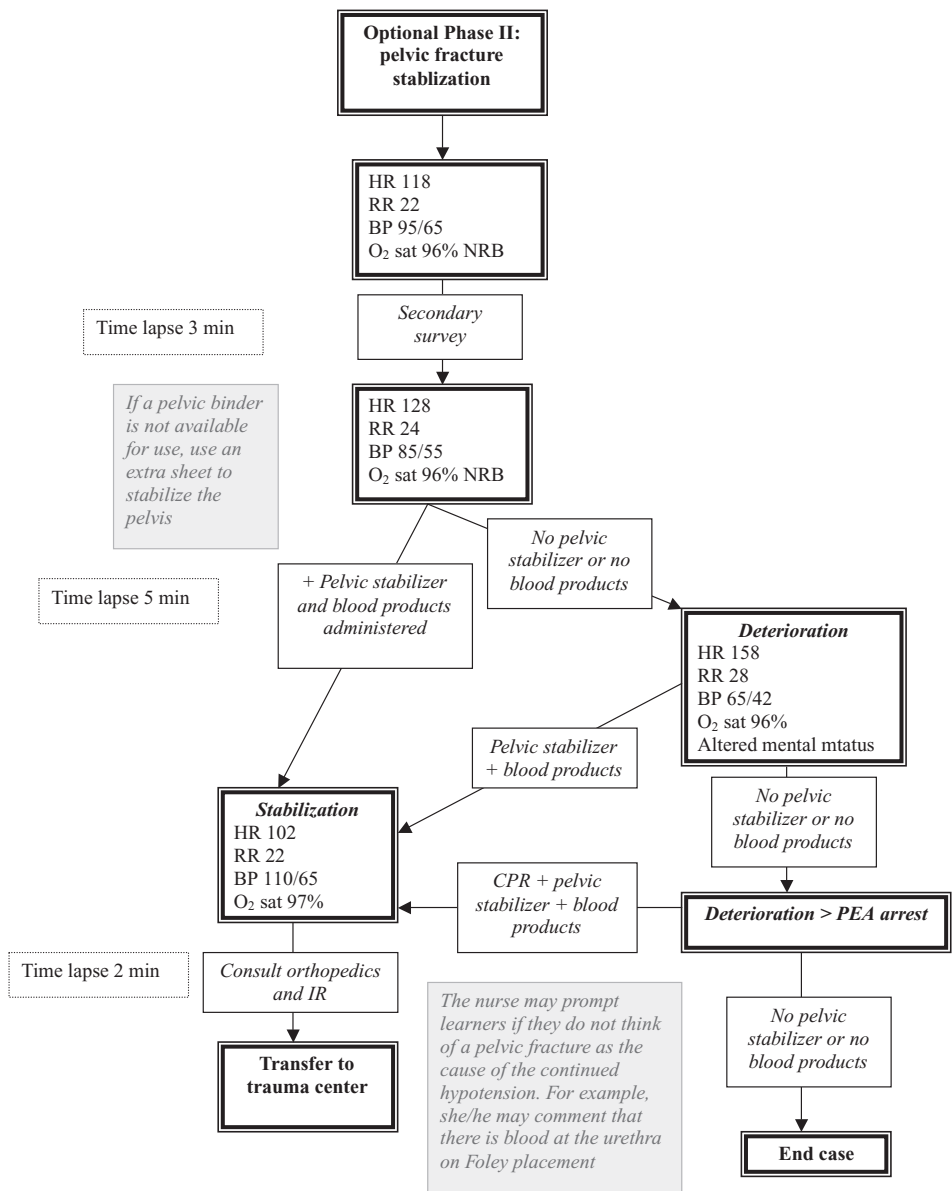


Figure 13.2 (Continued)

Instructor notes

Background

- Polytrauma refers to the condition in which a patient has been subjected to multiple traumatic injuries. In the United States, it is common to manage these patients following Advance Trauma Life Support (ATLS) guidelines typically beginning with a primary survey followed by a secondary survey once the patient has been stabilized.
- The purpose of the primary survey is to identify any imminent life threats and simultaneously treat. The five components of the primary survey include:
 - Airway.
 - Breathing.
 - Circulation.
 - Disability.
 - Exposure.
- Secondary survey:
 - Complete history and physical examination to identify any non-life-threatening injuries.

Pneumothorax

Clinical features

- Pleuritic chest pain.
- Shortness of breath/respiratory distress
- If tension physiology is present may also find:
 - Hypotension.
 - Tachycardia.
 - Jugular venous distension.
 - Hypoxia.
 - Tracheal deviation away from the side with the pneumothorax.
 - Diminished breath sounds on affected side.
 - Pulsus paradoxus.
 - Complete circulatory collapse with PEA arrest or asystole.

Diagnosis

- Chest X-ray is the primary imaging technology:
 - Tension pneumothorax is primarily a clinical diagnosis.
- Ultrasound may be used for bedside diagnosis by an experienced operator.
- CT scan is very sensitive, but requires more time to perform and the patient must physically leave the treatment area to have the study done.

Management

- 100% supplemental oxygen.
- Small (<15–20%) pneumothoraces in minimally symptomatic patients can be managed conservatively with observation only.

- Chest tube thoracostomy is the definitive treatment:
 - If the patient is hemodynamically unstable, a needle thoracostomy can first be performed, followed by placement of a chest tube.

Pelvic fracture

Clinical features

- Pain, laxity, or instability with palpation of the pelvis.
- Hematuria or blood at the urethral meatus, vaginal introitus, or rectum.
- Hematoma of the perineum, flank, thigh, scrotum, or inguinal region.
- High-riding or boggy prostate.

Diagnosis

- Pelvic X-ray will diagnose the majority of fractures and is the most suitable study for the unstable patient:
 - Normal pubic symphysis is less than 5 mm wide and has less than 3 mm of vertical offset.
- CT scan is very sensitive, but requires more time to perform and the patient must physically leave the treatment area to have the study done:
 - Not recommended for unstable patients.

Management

- Avoid excessive or forceful manipulation of the pelvis, which may displace a fracture fragment, worsen instability, or disrupt a pelvic hematoma.
- Stabilize pelvis:
 - Compression with a pelvic binder, or a sheet if a pelvic binder is unavailable.
 - Orthopedic surgery consultation for possible placement of an external fixator device or surgical intervention.
- Treat hypovolemia:
 - IV fluids and blood products.
 - Consult interventional radiology for potential embolization of bleeding vessels in the unstable patient.
- Foley catheter should be avoided until urethral injuries can be ruled out by retrograde urethrogram:
 - A suprapubic catheter can be placed if a urethrogram cannot be performed and a urinary catheter is necessary.
 - Urology should be consulted for any suspected urethral injuries.

Debriefing plan

Plan for ~30 min for discussion.

Potential questions for discussion:

- What is the standard approach to a trauma patient?
- What are the signs of traumatic shock?
- What are the signs of tension pneumothorax?

- What is the treatment for tension pneumothorax?
- What is the treatment for an open-book pelvic fracture?
- When should a blood transfusion be considered in a trauma patient?
- Is it okay to place a Foley catheter in a patient with an open-book pelvic fracture?
- What specialties should be consulted for patients with open-book pelvic fractures?

Selected reading

1. DiGiacomo JC, Bonadies JA, Cole FJ, *et al.* Practice management guidelines for hemorrhage in pelvic fracture. Chicago: Eastern Association for the Surgery of Trauma, 2001. Available from: <http://www.east.org/research/treatment-guidelines> (last accessed December 26, 2011).
2. Daley BJ. Pneumothorax. *MedScape* February 24, 2012. Available from: <http://emedicine.medscape.com/article/424547-overview> (last accessed May 20, 2012).
3. Mason C. Tube thoracostomy. In: Shah K, Mason C, eds. *Essential Emergency Procedures*. Lippincott Williams & Wilkins: Philadelphia, PA, 2008, pp. 26–31.

Pulseless lower extremity fracture with rhabdomyolysis/cervical spine fracture

Educational goals

Learning objectives

Primary:

1. Recognize clinical signs of pulseless limb [*Medical Knowledge*].
2. Order appropriate treatment for rhabdomyolysis/hyperkalemia [*Medical Knowledge, Patient Care*].
3. Recognize fracture with vascular compromise and order emergent consultation [*Medical Knowledge, Patient Care, Interpersonal and Communication Skills, Systems-based Practice*].
4. Recognize early neurogenic shock and treat appropriately [*Medical Knowledge, Patient Care*].
5. Perform proper intubation technique for cervical spine fracture [*Medical Knowledge, Patient Care*].

Secondary:

1. Demonstrate professionalism and communication skills in consulting the Intensive Care Unit (ICU) and working with ED nurse [*Interpersonal and Communication Skills, Professionalism*].
2. Direct proper disposition/appropriate consultation [*Systems-based Practice*].

Critical actions checklist

- ☐ Perform primary and secondary trauma surveys [*Medical Knowledge, Patient Care*]
- ☐ Order head CT and full spine series (X-rays or CT scan), pelvic imaging, and lower extremity imaging [*Patient Care*]
- ☐ Assess pulses in lower extremities [*Medical Knowledge*]
- ☐ Order appropriate medications for intubation with awareness of hypotension [*Medical Knowledge*]
- ☐ Continue in-line cervical spine immobilization during intubation [*Medical Knowledge, Patient Care*]
- ☐ Manage rhabdomyolysis with IVF (NS \pm sodium bicarbonate) and place Foley catheter to measure urine output [*Medical Knowledge, Patient Care*]
- ☐ Order vasopressors for persistent hypotension from neurogenic shock [*Medical Knowledge, Patient Care*]
- ☐ Consult orthopedics and/or neurosurgeon for management of cervical spine fracture [*Medical Knowledge, Interpersonal and Communication Skills*]
- ☐ Call and communicate to ICU for disposition [*Interpersonal and Communication Skills, Professionalism*]

Critical actions can be changed to address the educational needs of the learner. For example, a resident preparing for oral boards may have more specific critical actions oriented towards oral board review (e.g. order compartment pressure measurement, order pregnancy test).

Simulation set-up

Environment: Emergency Department treatment area or trauma bay.

Mannequin: Female simulator mannequin, bandage at knee joint with splint or moulaged with ecchymosis at proximal tibia, on a backboard with a cervical collar in place.

If you do not have a splint, backboard, or cervical collar available, you may improvise with cardboard supplies or Styrofoam cut to size.

Props: To be displayed on a plasma screen/computer screen or printed out on handouts in the scenario room when asked for/return from laboratory:

- Images (see online component for Pulseless Lower Extremity Fracture/Cervical Spine Fracture, *Scenario 13.3. ppt*, at www.wiley.com/go/thoureen/simulation/workbook):
 - Chest X-ray that shows normal cardiac silhouette.
 - Radiology report of normal CT head.
 - Cervical spine CT scan with fracture of C4/C5.
 - Thoracic and lumbar X-ray reports that are normal.
 - AP pelvis X-ray: normal.
 - Left proximal tibia X-ray with displaced fracture.
 - FAST examination: normal.
- Labs (see online component as above):
 - Complete blood count.
 - Basic metabolic panel.
 - Coagulation panel.
 - Urinalysis.
 - Urine microscopy.
 - Pregnancy test.
 - Creatine phosphokinase (CPK).
 - Arterial blood gas.

Available in the treatment room:

- Basic airway and code cart.
- Medications (actual containers filled with water replacing the medication, or labeled IV bags and syringes):
 - IVF: liter bags of normal saline (NS) and lactated Ringer's (LR) and 5% dextrose in water (D5W).
 - Rapid sequence intubation medications (sedative and paralytic typically used at your institution; however, make sure to include both depolarizing and non-depolarizing paralytics).
 - Ampules of sodium bicarbonate.
 - Norepinephrine, dopamine, and/or phenylephrine drip.

- Option: Foley catheter bag with “tea-colored” urine in it (to be prompted by nurse).
- Doppler probe.

Audio can be recorded for both normal and abnormal pulses and played when the learner tries to use it on the extremity. If not available, you may also have the nurse prompt what it sounds like, i.e. “I don’t hear anything on that leg.”

- Glidescope (Verathon, Inc., Bothwell, WA) or other advanced airway device. This may be used, if available at your facility, for use in the management of definitive airway with an unstable cervical spine.

Distractor: None.

Actors:

- Paramedic(s) are able to provide information about the scene, but only if specifically asked.

Altering input from actors is a good way to increase/decrease scenario difficulty. For example, EMS can point out the swollen or deformed leg or may not add any information in the physical examination.

- Female patient is lethargic and moans in response to pain. She can open her eyes and wiggle her fingers and toes on right lower extremity (prompted by nurse).
- Option: Friend of hiker can provide past medical history if asked. If this actor is not present, then all of PMH, etc., is unknown.
- ED nurse can start IVs and administer medications/IVF. The nurse does have some medical knowledge base and may cue learners if needed. The ED nurse may also prompt physical findings such as the bruising or swelling of the lower extremity.
- ICU physician and/or orthopedic consultant can be available via “phone consultation” if you do not have an additional actor present.

Case narrative

Scenario background

A 33-year-old female found by hikers after falling off a trail ledge while hiking. The patient was unconscious, but breathing. She was outside for ~8 h before being found.

Assume that this is a temperate season outside. For increased difficulty, hyperthermia or hypothermia could be added, depending on the season in which you are teaching this case.

Background may be presented prior to case, by EMS, or given as a triage sheet.

Medical history data is given by friend/hiker if present or requested:

CC: Fall.

PMH: Asthma.

Meds: Albuterol inhaler.

Allergies: None.

Family Hx: Unknown.

Social Hx: No smoking, social alcohol use, no illicit drug use.

Initial scenario conditions

Lethargic female on a stretcher with cervical collar and backboard in place.

VS: Temp. 36.7 °C (98 °F), HR 70, RR 8, BP 85/60, O₂ sat 96% on RA trending down to low 90s.

Note: The temperature may change if you want to add in an extra element of hypothermia or hyperthermia management.

- Eyes: Equal, reactive, open to pain. The nurse can prompt this if your mannequin does not have functional eyes.
- Neck: In cervical collar, patient moans with palpation.
- Heart: Tachycardia, no murmurs.
- Lungs: Equal bilaterally, clear to auscultation.
- Abdomen: Soft, no tenderness elicited.
- Pelvis: Stable, no tenderness elicited.
- Rectal: Normal tone, but patient will not respond to testing sensation in the perineal area.
- Extremities: Pulseless left lower extremity, swelling and ecchymosis on proximal left lower leg. Patient does not move extremities if asked or seem to respond to painful stimuli (this may be verified by the nurse), except on the right lower extremity and intermittently on the upper extremities. Nurse may also prompt, "That leg looks really swollen!" "It feels really hard!"

- Neurologic: Patient does not follow commands and opens her eyes to painful stimuli on the medial aspect of her upper extremities and face only. She moans in response to questioning.

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners. For example, if your mannequin does not have palpable pulses, you can verbally report the vascular examination when it is requested.

See the flow diagram in Figure 13.3 for further scenario changes as described below.

Case narrative, continued

The patient will require intubation secondary to decreased responsiveness/low Glasgow Coma Scale (GCS) score (motor = 4, verbal = 2, eye opening = 2). Learners need to be mindful of the cervical spine stability and the choice of paralytic, as the patient will have an unstable spinal fracture and potential hyperkalemia from her crush/traumatic injury to her leg.

The initial vital signs will show hypotension that is secondary to neurogenic shock and will not respond to IVFs. The learner should exclude other causes of shock in trauma (e.g. hemorrhagic shock) via FAST, pelvic X-ray, chest X-ray and complete blood count and then begin IV vasopressors, with phenylephrine and norepinephrine being the best choices. If vasopressors are not started, then the patient remains hypotensive despite IVF until they are started.

The learner should consult with orthopedic surgery and neurosurgery and secure disposition in the ICU. If the learner tries to consult orthopedic surgery or neurosurgery before ruling out hemorrhagic shock the consultants will refuse the consult until this is done.

The learner will need to consult orthopedic surgery for fasciotomy of the left lower extremity and neurosurgery for further management of the cervical spine fracture. If one or both specialists are not consulted, the intensivist may prompt the learner.

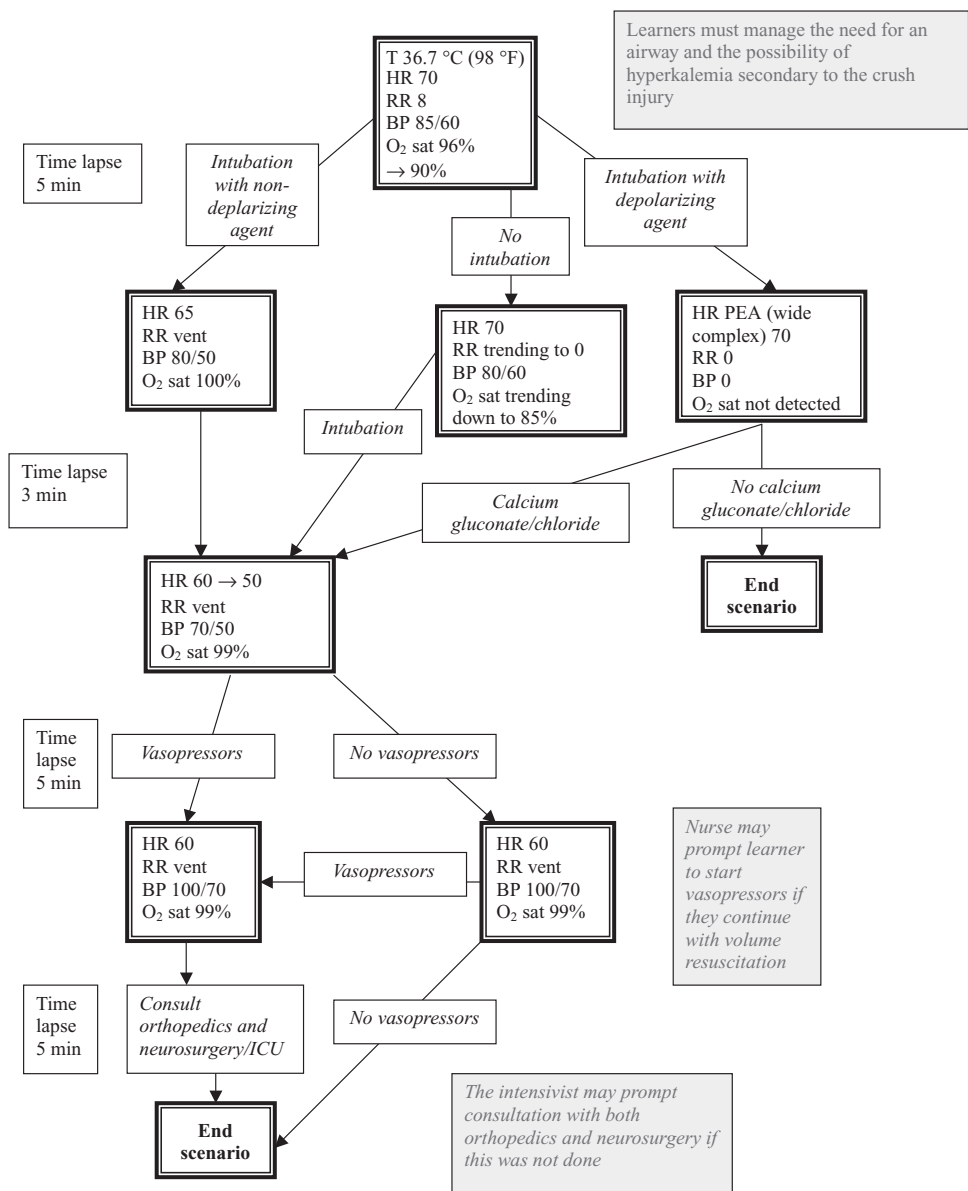


Figure 13.3 Scenario flow diagram: pulseless lower extremity fracture/cervical spine fracture.

Instructor notes

Cervical spine fracture

Pathophysiology

- Classified in terms of mechanisms of injury:
 - Flexion: e.g. wedge compression, flexion teardrop, anterior subluxation, bilateral facet dislocation, clay shoveler, and anterior atlantoaxial dislocation.
 - Flexion-rotation: e.g. unilateral facet dislocation and rotary atlantoaxial dislocation.
 - Extension: e.g. hangman fracture, extension teardrop fracture, fracture of the posterior arch of C1, and posterior atlantoaxial dislocation.
 - Vertical compression: e.g. Jefferson fracture, burst fracture, atlas fracture, and isolation fracture of the lateral mass of C1.

Diagnosis

- Based on evaluation with X-ray, CT, or MRI:
 - Current trauma recommendations³ recommend CT of the cervical spine with suspicion of neck injury in trauma (skip radiographs).
 - Clinical guidelines to guide imaging:
 - NEXUS (National Emergency X-radiography Utilization Study):
 - No posterior midline tenderness.
 - No intoxication.
 - Normal alertness.
 - No focal neurologic deficit.
 - No painful, distracting injury.
 - Canadian C-spine rules:
 - GCS 15.
 - No intoxication.
 - No distracting injury.
 - Able to rotate neck 45°.
 - Low risk: rear-end motor vehicle collision, seated position in ED, ambulation post-trauma, delayed onset of neck pain, and absence of midline cervical spine tenderness.
 - Excludes patients >65 years old, dangerous mechanism, or with paresthesias.
 - Physical finding which may suggest cervical spine injury include:
 - Spinal shock:
 - Flaccidity, areflexia, loss of sphincter tone, fecal incontinence, priapism, loss of bulbocavernosus reflex.
 - Neurogenic shock:
 - Hypotension, paradoxical bradycardia, flushed, dry, and warm peripheral skin.
 - Autonomic dysfunction:
 - Ileus, urinary retention, poikilothermia.

Management

- Proper consultation and cervical spine immobilization with hard collar.
- Steroids are no longer recommended.
- Vasopressors for neurogenic shock:
 - Dopamine or norepinephrine preferred.
 - Phenylephrine with caution secondary to reflexive bradycardia.

Compartment syndrome*Background*

- The secondary survey of the trauma evaluation involves evaluation of the extremities.
- Common locations of orthopedic fractures causing compartment syndrome are tibia, forearm, foot, hand, gluteal region, and thigh.

Pathophysiology

- Increased pressure within an osteofascial compartment of muscle causes ischemia and necrosis.

Diagnosis

- Symptoms/signs:
 - Pain out of proportion to examination and increased by passive range of motion.
 - Paresthesia.
 - Decreased sensation or functional loss of peripheral nerves that traverse the involved compartment.
 - Tense swelling.
 - Weakness or paralysis and loss of pulses are late signs.
 - Tissue pressure >35–45 mmHg suggests decreased blood flow. A direct pressure measuring device needs to be used, either commercially available such as the Stryker (Kalamazoo, MI) intra-compartmental pressure tonometer or assembling one of your own.⁴

Management

- Fasciotomy.
- Surgical management of fractures/vascular injuries.
- Laboratory evaluation should include:
 - Renal function.
 - Urinalysis.
 - Urine myoglobin.
 - CPK.
 - Serum chemistry studies.
 - Complete blood count.
 - Coagulation studies.
- Fluid management:
 - Isotonic crystalloid for rhabdomyolysis: start at 500 cm³/h.

- Maintain urine output of 200–300 cm³/h.
- Also consider urinary alkalization with sodium bicarbonate infusion in patients with high CPK.
- Complications:
 - Scarring.
 - Infection.
 - Irreversible tissue ischemia leading to amputation.
 - Rhabdomyolysis.
 - Permanent nerve damage.

Debriefing plan

Plan for ~30 min for discussion.

Potential questions for discussion

1. What is the most common injury to the lower extremity to cause loss of pulses? What else is in the differential?
2. What are the two currently accepted clinical guidelines or rules for evaluation of the cervical spine? What are the criteria they set out for further evaluation?
3. What important potential electrolyte abnormality must be considered when managing compartment syndrome?

Selected reading

1. Rozycki G, Tremblay L, Feliciano D, McClelland W. Blunt vascular trauma in the extremity: diagnosis, management, and outcome. *J Trauma* 2003;**67**:814–824.
2. Como J, Diaz J, Dunham M, *et al.* Practice management guidelines for identification of cervical spine injuries following trauma: update from the Eastern Association for the Surgery of Trauma Practice Management Guidelines Committee. *J Trauma* 2009;**67**:651–659.
3. Kortbeek J, Turki S, Ali J, *et al.* Advanced trauma life support, 8th edition, the evidence for change. *J Trauma* 2008;**64**:1638–1650.
4. Rasul AT. Acute compartment syndrome. *MedScape* November 11, 2011. Available from: <http://emedicine.medscape.com/article/307668-overview> on 2011 Dec 17 (last accessed May 20, 2012).
5. Guly HR, Bouamra O, Lecky FE. The incidence of neurogenic shock in patients with isolated spinal cord injury in the emergency department. *Resuscitation* 2008;**76**:57–62.

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